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Endangered Species Act - Section 7 Consultation

# BIOLOGICAL OPINION

**On Studies Sampling Salmonid Predators Off the Mouth of the Columbia River and the Distribution of Juvenile Salmon and Associated Biota Off Oregon and Northern California**

Agency: National Marine Fisheries Service,
Northwest Fisheries Science Center

Consultation Conducted By:
National Marine Fisheries Service,
Sustainable Fisheries Division

Date Issued: 21 March 2001

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Director, Office of Protected Resources

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# INTRODUCTION

This biological opinion considers the effects of two research studies proposed by the National Marine Fisheries Service (NMFS), Northwest Fisheries Science Center, Fish Ecology Division on salmonids listed under the Endangered Species Act (ESA) of 1973. The proposals concern the continuation of an ongoing study sampling salmonid predators off the mouth of the Columbia River (salmonid predation study), and the initiation of a study sampling the distribution of juvenile salmon and associated biota off Oregon and northern California (juvenile salmon distribution study). The two studies are being considered in a single biological opinion because of the similar nature of the work, the fact that both studies are being proposed by NMFS, Northwest Fisheries Science Center (NWFSC), the limited impacts associated with the studies, and for reasons of efficiency in completing the necessary consultations.

NMFS is both the action agency and the consulting agency for these two research studies. NMFS, Northwest Region, Office of Sustainable Fisheries received two letters requesting initiation of section 7 consultation. Each letter included a study proposal and a associated biological assessment. The first letter from M. H. Schiewe, NWFSC dated February 22, 2000, requested renewal of the expired informal consultation regarding the salmonid predation study, dated June 11, 1997 (Stelle, Jr. 1997). Consultation was reinitiated because NMFS determined that the proposed activities “may adversely affect” listed species, the original consultation expired following the 1999 field season, and because new salmonids have been added to the ESA list (Table 1) since the last consultation on July 11, 1997. The second letter, also from M. H. Schiewe, dated February 23, 2000, requested the initiation of consultation regarding a proposed juvenile salmon distribution study which also was dtermined to have the potential for adverse effects to listed species. Both studies are proposed to continue through 2004.

Both the salmonid predation and the juvenile salmon distribution studies focus on the early life history of salmonids off the west coast. Relatively little is known about early survival of salmonids in the marine environment, which is believed to be a critical determinant of adult abundance. The two proposed studies considered in this opinion are part of a coordinated research plan for estuarine and ocean research on Pacific salmon (Brodeur et al. 2000). The information gained through this coordinated research will contribute greatly to our understanding the relationship between ocean conditions and survival of salmonids during this critical stage of their lives.

# CONSULTATION HISTORY

NMFS previously considered the impacts to salmon species listed under the ESA resulting from the salmonid predation study in an informal section 7 consultation, dated July 11, 1997 (Stelle, Jr. 1997). However, because the previous consultation expired in 1999, NMFS is reinitiating consultation to consider impacts to listed species (Table 1), including ESUs listed since the initial consultation (Schiewe 2000a). NMFS has not consulted previously on the proposed juvenile salmon distribution study (Schiewe 2000b).

NMFS conducted an initial preliminary assessment of the proposed studies. Under ESA section 7(d), the NMFS, Northwest Region drafted a letter dated April 24, 2000 (Stelle, Jr. 2000) that summarized the preliminary assessment of the proposed studies which considered the impacts to listed species that may occur during the ongoing consultation. Based on the best available scientific and commercial data, NMFS concluded that implementation of the initial phases of the research studies prior to July 1, 2000 would not constitute any irreversible or irretrievable commitment of resources with respect to the agency action which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternatives which would not violate subsection 7(a)(2). NMFS issuance of this biological opinion will conclude consultation on the proposed studies.

**Table 1. Summary of salmonid species listed and proposed for listing under the ESA.**

| Species | Evolutionarily Significant Unit | Present Status | Federal Register Notice | |
|---|---|---|---|---|
| Chinook Salmon (*O. tshawytscha*) | Sacramento River Winter | Endangered | 54 FR 32085 | 8/1/89 |
| | Snake River Fall | Threatened | 57 FR 14653 | 4/22/92 |
| | Snake River Spring/Summer | Threatened | 57 FR 14653 | 4/22/92 |
| | Central Valley Spring | Threatened | 64 FR 50394 | 9/16/99 |
| | California Coastal | Threatened | 64 FR 50394 | 9/16/99 |
| | Puget Sound | Threatened | 64 FR 14308 | 3/24/99 |
| | Lower Columbia River | Threatened | 64 FR 14308 | 3/24/99 |
| | Upper Willamette River | Threatened | 64 FR 14308 | 3/24/99 |
| | Upper Columbia River Spring | Endangered | 64 FR 14308 | 3/24/99 |
| Chum Salmon (*O. keta*) | Hood Canal Summer-Run | Threatened | 64 FR 14508 | 3/25/99 |
| | Columbia River | Threatened | 64 FR 14508 | 3/25/99 |
| Coho Salmon (*O. kisutch*) | Central California Coastal | Threatened | 61 FR 56138 | 10/31/96 |
| | S. Oregon/ N. California Coastal | Threatened | 62 FR 24588 | 5/6/97 |
| | Oregon Coastal | Threatened | 63 FR 42587 | 8/10/98 |
| Sockeye Salmon (*O. nerka*) | Snake River | Endangered | 56 FR 58619 | 11/20/91 |
| | Ozette Lake | Threatened | 64 FR 14528 | 3/25/98 |
| Steelhead (*O. mykiss*) | Southern California | Endangered | 62 FR 43937 | 8/18/97 |
| | South-Central California | Threatened | 62 FR 43937 | 8/18/97 |
| | Central California Coast | Threatened | 62 FR 43937 | 8/18/97 |
| | Upper Columbia River | Endangered | 62 FR 43937 | 8/18/97 |
| | Snake River Basin | Threatened | 62 FR 43937 | 8/18/97 |
| | Lower Columbia River | Threatened | 63 FR 13347 | 3/19/98 |
| | California Central Valley | Threatened | 63 FR 13347 | 3/19/98 |
| | Upper Willamette River | Threatened | 64 FR 14517 | 3/25/99 |
| | Middle Columbia River | Threatened | 64 FR 14517 | 3/25/99 |
| | Northern California | Proposed Threatened | 65 FR 6960 | 2/11/00 |

## BIOLOGICAL OPINION

## I. Description of the Proposed Actions

### A. Proposed Actions

### Salmonid Predation Study

The NWFSC, Fish Ecology Division/ Estuarine and Ocean Ecology Program is in the third year of a multi-year (1998-2004) study of marine predation of juvenile salmonids off the mouth of the Columbia River, particularly by Pacific mackerel, *Scomber japonicus*, and Pacific hake, *Merluccius productus*. The original start date was scheduled for the summer of 1997, but the desired research vessel could not be procured. The 1998 study year was a preliminary exercise to test sampling techniques and to determine the best sampling sites. The 1999 year was the first full year with the finalized study design and sampling techniques. The original duration of the study has now been extended through 2004.

Until this study was initiated, research sampling for hake and mackerel and other marine fish predators directly off the mouth of the Columbia River by mid-water/surface trawl had not been conducted. Results from the last two years of sampling indicates that the capture of some adult or subadult salmonids during surveys may occur.

Marine fish predators will be collected by surface trawling primarily during nighttime by a contracted commercial mid-water trawler towing a 264 Nordic Rope trawl and 3m foam-filled doors. Sampling will be conducted for 2 days approximately every 10 days from late April through June each year for a total of 10 sampling trips or 20 days per year. Potential salmonid predators will be identified, measured and weighed and stomachs removed and preserved. A subsample will be taken when large catches occur. The study expects to collect approximately 100-200 fish stomachs for each of the 10 day trips each year. All other fishes will also be identified and measured.

There are four overall objectives to the proposed research:

1) Identify the temporal dynamics and abundance of marine fish predators and forage fishes in the nearshore ocean off the Columbia River during the juvenile salmon outmigration period. By regularly sampling in marine waters adjacent to the Columbia River the study will identify the characteristics of fish communities which salmonid smolts are interacting with during the peak smolt migration period (end of April through June) and whether that community is static or dynamic.

2) Identify the food habits of predatory marine fishes. The study will describe the temporal and dynamic nature of the trophic links between potential juvenile salmon marine fish predators and the available prey field. Stomach analysis of large marine pisciverous fishes will reveal if these predators are eating salmonids (some possibly endangered stocks), and at what rate.

3) Measure selected oceanographic conditions in the nearshore ocean off the Columbia River.

Distribution and abundance of marine fishes are affected by physical oceanographic conditions (temperatures, salinities, etc.). Measurements of these physical conditions will provide information on these possible controlling factors.

4) Relate predator and forage fish distribution and abundance to oceanographic conditions and ocean survival of juvenile salmonids historically and to the present. Elements in this objective are designed to utilize the information generated from Objectives 1-3 to address 4 principle questions: a) describe the current and historical relationship between marine fish predator and prey field communities off the Columbia River during the spring and early summer period, b) identify the relationship between changing ocean conditions off the Columbia River during the spring and early summer and the marine fish predator and prey field community, c) identify the relationship between marine fish (predators and prey) ecology, changing ocean conditions, and ocean survival of juvenile salmonids, and d) relate the temporal and dynamic nature of the oceanographic condition and marine fish ecology off the Columbia River to regular (weekly) estimates of salmon ocean survival using timing of tagged groups.

**Juvenile Salmon Distribution Study**

In 2000, the NWFSC, Fish Ecology Division/Estuarine and Ocean Ecology Program and co-operators, began an integrated study of the pelagic fish ecology in the ocean region from Newport, OR, south to Eureka, CA. This study is a component of a broader study and was submitted pursuant to the Request for Proposals by the Coastal Ocean Program, National Oceanic and Atmospheric Administration (NOAA), for the Northeast Pacific Global Ocean Ecosystem Dynamics (GLOBEC) Project. This will be a five year study (2000-2004). The primary focus of this research study is to understand the direct and indirect linkages between oceanographic conditions and salmon survival in the marine environment.

The objective of the juvenile distribution study is to identify the spatial and temporal dynamics of juvenile salmonids and associated taxa (other fishes and invertebrates), the oceanographic conditions affecting these fishes (physical and biological), and how these conditions influence salmonid marine survival, particularly in the context of long-term global warming.
The study proposes to compare and contrast juvenile salmon distributions and the associated biological community and oceanographic conditions spatially by sampling north and south of Cape Blanco (Newport, OR to Eureka, CA). The proposed site for the May sampling will be a region of high productivity near Hecata Bank, OR. A second site for the September process study would be within some of the offshore jets south of Cape Blanco. Since the study has access to the only comparable historical data set within the region (coastal Oregon), it will also compare and contrast juvenile salmon distribution and the associated biological community and oceanographic conditions from a temporal perspective (current conditions to conditions in 1979-1985). In addition, sampling of juvenile salmon and associated biota will occur for the first time on a finer scale within these regions and the incidental take of some listed salmonids may occur.

The sampling began in 2000 with additional sampling scheduled for every other year (2002, and 2004), with between years used for data analysis and 2005 for final analysis. The study proposal expects to conduct approximately 60 trawls per sampling cruise. These cruises will be conducted in conjunction with other proposed sampling of the physics, nutrients, primary productivity, and zooplankton (net and acoustic sampling) to be carried out from another research vessel. Sampling stations will be set along pre-determined transects running from Newport to Eureka. Where possible, the same transects will be sampled as in the 1980s sampling, so that interdecadal comparisons in catch composition for the same months can be made. Following the broad-scale sampling, the vessel will coordinate with other planned process studies to examine juvenile salmon fine scale habitat utilization for an additional two 8 day cruises, one during May/June and the other in August.

There are four overall objectives to the proposed research:

1) Identify the temporal and spatial dynamics of juvenile salmon and their associated taxa (predators and forage fishes) in the coastal ocean off Southern Oregon and Northern California during the juvenile salmon outmigration period (spring) and following a period of ocean residence (fall). Extensively sampling in coastal waters will identify the characteristics of the biotic community with which salmonid smolts interact during their peak smolt migration period (end of April through June) and also determine whether this community is static or dynamic in space and time.

2) Identify the abundance and distribution patterns of potential marine fish predators and competitors occurring in the vicinity of juvenile salmonids. The study will describe the temporal and dynamic nature of the spatial overlap of salmon and potential marine fish predators and competitors of juvenile salmon and the available prey field. This will be accomplished by doing trawl surveys during daytime and acoustic sampling (from another vessel) throughout the diel period. The species composition of the fish comprising the acoustic signal will be verified periodically by trawl sampling.

3) Measure selected oceanographic conditions in the nearshore ocean at the time of the collections. The horizontal and vertical distribution and abundance of marine fishes are affected by physical oceanographic conditions (temperature, salinity, density structure, depth of thermocline, etc.). Measurements of these physical conditions using the SeaSoar by other GLOBEC investigators during the Mesoscale Surveys and Process Studies will be the study's chief source of information. In addition, the study will make use surface current information from a Coastal Radar (CODAR) installation at Newport, OR. M. Kosro (OSU/Oceanography) and associates produce hourly fields of surface currents with 1 km resolution, from 3 radar units, centered at Newport , with a range of approximately 50 km to sea and 75 km north and south of Newport. This area includes the Heceta Bank region that will be studied in detail during the May process cruise. The surface current data may be the most valuable data stream to us because juvenile salmon inhabit the upper 5-10 m of the water column. Other data sources that the study will use include upwelling indices from NOAA-PFEG and sea surface temperature, ocean color and other satellite data from the Strub-Thomas-Svjkovsky GLOBEC project.

4) Relate predator and forage fish distribution and abundance to oceanographic conditions and ocean survival of juvenile salmonids historically and to the present. Elements in this objective are designed to utilize the information generated from Objectives 1-3 to address three principle questions: a) What are the current and historical relationship between marine fish predator and prey field communities off the west coast during the spring and early fall period? b) What is the

relationship between changing ocean conditions off the Oregon and northern California coast during the spring and early fall and the marine predator and prey field community? c) What is the relationship between marine predators and prey ecology, changing ocean conditions, and ocean survival of juvenile salmonids?

B. Conservation Measures Included in the Proposed Actions

**Salmonid Predation Study**

Non-target species, including a small number of adult or juvenile Pacific salmon (possibly juvenile and adult listed salmonids), may be captured incidentally during sampling efforts for hake and mackerel and other fishes. Because of the small number of salmon collected and the small percentage of listed salmonid off the Columbia River, the likelihood that any listed species will be captured is small. Since the trawls will be of short duration, it is anticipated most adult salmon will survive capture. All adult salmon captured during sampling will be released. Most juvenile salmon captured in the surface trawl do not survive collection. As such, these fishes will be saved for stomach analysis, and coded-wire tag (CWT) information and other data. This information will provide data to an ongoing NWFSC/Estuarine and Ocean Ecology Program study of juvenile salmonid growth in relation to the Columbia River plume dynamics.

**Juvenile Salmon Distribution Study**

In past research using the Nordic 264 trawl off the Columbia River suggests that relatively few salmon are caught compared to other pelagic fishes. All fishes caught will be counted and measured at sea. All juvenile salmon caught will be frozen for later analysis of growth, condition, pathology, genetic analysis, and food habits. Adult salmon will be identified and measured and gently released back into the ocean unless they have a CWT. Adult salmonids with CWT will be sacrificed so place of origin can be determined. Juvenile salmon will be transported back to the Hatfield Marine Science Center laboratory in Newport, OR, or the NWFSC in Seattle, WA, for detailed dissection and analysis.

C. Action Area

The predation study will sample for hake and mackerel and other marine fish predators directly off the mouth, north and south of the entrance, of the Columbia River by mid-water/surface trawl.

The juvenile salmon distribution study will be sampling juvenile salmon distributions and the associated biological community and oceanographic conditions north and south of Cape Blanco, Oregon (Newport, OR, to Eureka, CA).

## II. Status of the Species and Critical Habitat

There are 25 salmonid species or ESUs currently listed as threatened or endangered under the ESA (Table 1) that are potentially affected by the proposed studies. Analysis in the Effects of the Actions section indicates that there are few, if any, effects to chum, sockeye, and steelhead ESUs, but that chinook and coho are likely to be caught on occasion as a result of the proposed studies.

Chinook salmon from the Columbia River Basin and Puget Sound are most likely to be taken in the salmonid predation study (i.e. Snake River Fall chinook, Snake River Spring/Summer chinook, Puget Sound chinook, Lower Columbia River chinook, Upper Willamette River chinook, Upper Columbia River Spring chinook). Chinook salmon stocks from the listed California ESUs (i.e. Sacramento River Winter chinook, Coastal California chinook, and Central Valley Spring chinook) and possibly Snake River Fall chinook are most likely to be taken in the juvenile distribution study. Both studies may adversely affect any of the three listed coho ESUs (i.e. Central California coho, Southern Oregon/Northern California Coasts coho, and Oregon Coast coho).

Descriptions of the key features of life history, population dynamics and distribution of the salmonids which may be encountered can be found in the following status reviews: chinook salmon - Myers, et al. (1998 & 1999), Healey (1991), and Waples, et al. 1991; coho salmon - Weitkamp, et al. (1995) and in recent biological opinions (Table 2). Conclusions regarding the status of the chinook and coho ESUs are summarized below.

**Table 2. References containing more detailed discussions concerning the status of each species and the related Environmental Baseline.**

| Species | ESU | Reference |
|---|---|---|
| Chinook Salmon *(O. tshawytscha)* | Puget Sound | NMFS 2000a |
| | Lower Columbia River | NMFS 2000a |
| | Upper Willamette River | NMFS 2000c |
| | Snake River Spring/Summer | NMFS 2000c |
| | Snake River Fall | NMFS 2000b |
| | Upper Columbia River Spring | NMFS 2000c |
| | Central Valley Spring<br>California Coastal | NMFS 2000d |
| | Sacramento River Winter | NMFS 1997 |
| Coho Salmon *(O. kisutch)* | Central California Coastal<br>S. Oregon/N. California Coastal<br>Oregon Coastal | NMFS 1999 |

A. Species and Critical Habitat Description

1. Chinook Salmon

The Puget Sound (PS) chinook ESU includes all runs of chinook salmon in the Puget Sound region from the North Fork Nooksack River to the Elwha River on the Olympic Peninsula. Chinook salmon in this area all exhibit an ocean-type life history although there are several populations with an adult spring run timing and ocean distribution. Although some spring-run chinook salmon populations in the PS ESU have a high proportion of yearling smolt emigrants, the proportion varies substantially from year to year and appears to be environmentally mediated rather than genetically determined. Spring-run chinook hatchery populations from Kendall Creek, the North Fork Stillaguamish River, White River, and Dungeness River, and fall run fish from the Elwha River are listed. Critical habitat was designated for PS chinook on February 16, 2000 (65 FR 7764).

The Snake River (SR) spring/summer chinook ESU includes all natural-origin populations of spring/summer chinook in the Tucannon, Grande Ronde, Imnaha, and Salmon rivers. Some or all of the fish returning to several of the hatchery programs are also listed including those returning to the Tucannon, Imnaha, Grande Ronde Rivers and the Sawtooth, Pahsimeroi, and McCall hatcheries on the Salmon River. Critical habitat was designated for SR spring/summer chinook on December 28, 1993 (58 FR 68543) and revised on October 25, 1999 (64 FR 53799).

The Upper Columbia River (UCR) spring chinook ESU includes stream-type chinook salmon spawning above Rock Island Dam including the Wenatchee, Entiat, and Methow River basins. All chinook in the Okanogan River are apparently ocean-type and are considered part of the Upper Columbia River Summer-and Fall-run ESU. Several hatchery populations are also listed including those from the Chiwawa, Methow, Twisp, Chewuch, and White rivers, and Nason Creek. Critical habitat was designated for UCR spring chinook on February 16, 2000 (65 FR 7764).

The (SR) fall chinook ESU includes all natural-origin populations of fall chinook in the mainstem Snake River and several tributaries including the Tucannon, Grande Ronde, Salmon, and Clearwater rivers. Fall chinook from the Lyons Ferry Hatchery are included in the ESU but are not listed. Critical habitat was designated for SR fall chinook on December 28, 1993 (58 FR 68543).

The Lower Columbia River (LCR) ESU includes all native populations from the mouth of the Columbia River to the crest of the Cascade Range, excluding populations above Willamette Falls. Celilo Falls, which corresponds to the edge of the drier Columbia Basin Ecosystem and historically may have presented a migrational barrier to chinook salmon at certain times of the year, is the eastern boundary for this ESU. Not included in this ESU are "stream-type" spring-run chinook salmon found in the Klickitat River (which are considered part of the Mid-Columbia River Spring-Run ESU) or the introduced Carson spring-chinook salmon strain. "Tule" fall chinook salmon in the Wind and Little White Salmon Rivers are included in this ESU, but not introduced "upriver bright" fall-chinook salmon populations in the Wind, White Salmon, and Klickitat Rivers. For this ESU, the Cowlitz, Kalama, Lewis, White Salmon, and Klickitat Rivers are the major river systems on the Washington side, and the Willamette and Sandy Rivers are foremost on the Oregon side. The majority of this ESU is represented by fall-run fish and includes both north migrating tule-type stocks and far-north migrating bright stocks. There is discussion among some co-managers as to whether any natural-origin spring chinook salmon persist in this ESU. Fourteen hatchery stocks were included in the ESU; one was considered essential for recovery (Cowlitz River spring chinook) but was not listed. Critical habitat was designated for LCR chinook on February 16, 2000 (65 FR 7764).

The Upper Willamette River (UWR) chinook ESU occupies the Willamette River and tributaries upstream of Willamette Falls. Historically, access above Willamette Falls was restricted to the spring when flows were high. In autumn low flows prevented fish from ascending past the falls. The Upper Willamette spring chinook are one of the most genetically distinct chinook groups in the Columbia River Basin. Fall chinook salmon spawn in the Upper Willamette but are not considered part of the ESU because they are not native. None of the hatchery populations in the Willamette River are listed although the spring-run hatchery stocks were included in the ESU. Critical habitat was designated for UWR chinook on February 16, 2000 (65 FR 7764).

The California Coastal (CC) chinook ESU includes all naturally spawned coastal chinook salmon spawning from Redwood Creek south through the Russian River inclusive. Critical habitat was designated for CC chinook on March 9, 1998 (65 FR 7764).

The Central Valley Spring (CVS) chinook ESU includes chinook salmon entering the Sacramento River from late February to July and spawning from late August through early October, with a peak in September. Critical habitat was designated for CVS chinook on March 9, 1998 (65 FR 7764).

The Sacramento River winter-run (SRW) chinook ESU includes chinook salmon entering the Sacramento River from November to June and spawning in the upper Sacramento River below Keswick Dam from late-April to mid-August, with a peak from May to June. Critical habitat was designated for SRW chinook on June 16, 1993 (58 FR 33212).

2. Coho Salmon

The Oregon Coastal (OC) ESU includes naturally spawning populations of coho salmon inhabiting coastal streams between Cape Blanco and the Columbia River. After reviewing biological data on the species' status and an assessment of protective efforts, NMFS concluded in August 1997 that this ESU did not warrant listing. However, the Oregon District Court overturned the decision and NMFS listed the ESU as threatened on August 10, 1998. Critical habitat was designated for OC coho on February 16, 2000 (65 FR 7764).

The (Southern Oregon/Northern California Coho) SONCC ESU was listed as threatened on August 18, 1997. The SONCC ESU consists of all naturally spawning populations of coho salmon that reside below long-term, naturally impassible barriers in streams between Punta Gorda, California and Cape Blanco, Oregon. Five of the seven hatchery stocks reared and released within the range of the ESU are included in the definition of the ESU, however none of the hatchery populations are listed. Critical habitat for the ESU encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between the Mattole River in California and the Elk River in Oregon, inclusive (May 5, 1999, 64 FR 24049).

The (Central California Coho) CCC ESU consists of all coho reproducing in streams between

Punta Gorda and the San Lorenzo River, including hatchery stocks, with the exception of Warm Springs Hatchery on the Russian River. As in the case with OC and SONCC coho, CCC ESU hatchery stocks are not listed. Critical habitat for CCC ESU encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River, and Mill Valley and Corte Madera Creek which enter the San Francisco Bay (May 5, 1999, 64 FR 24049).

B. Life History

1. Chinook Salmon

Chinook salmon is the largest of the Pacific salmon. The species' distribution historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). Additionally, chinook salmon have been reported in the Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Of the Pacific salmon, chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for chinook salmon, 7 total ages with 3 possible freshwater ages. This level of complexity is roughly comparable to sockeye salmon, although sockeye salmon have a more extended freshwater residence period and utilize different freshwater habitats (Miller and Brannon 1982, Burgner 1991). Two generalized freshwater life-history types were initially described by Gilbert (1912): "stream-type" chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" chinook salmon migrate to the ocean within their first year. Healey (1983, 1991) has promoted the use of broader definitions for "ocean-type" and "stream-type" to describe two distinct races of chinook salmon. This racial approach incorporates life history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of chinook salmon populations. For the purposes of this Opinion, those chinook salmon (spring and summer runs) that spawn upriver from the Cascade crest are generally "stream-type;" those which spawn downriver of the Cascade Crest (including in the Willamette River) are generally "ocean-type."

The generalized life history of Pacific salmon involves incubation, hatching, and emergence in freshwater, migration to the ocean, and subsequent initiation of maturation and return to freshwater for completion of maturation and spawning. Juvenile rearing in freshwater can be minimal or extended. Additionally, some male chinook salmon mature in freshwater, thereby foregoing emigration to the ocean. The timing and duration of each of these stages is related to genetic and environmental determinants and their interactions to varying degrees. Salmon exhibit a high degree of variability in life-history traits; however, there is considerable debate as to what degree this variability is the result of local adaptation or the general plasticity of the salmonid genome (Ricker 1972, Healey 1991, Taylor 1991). More detailed descriptions of the key features of chinook salmon life history can be found in Myers, et al. (1998) and Healey (1991).

2. Coho Salmon

Coho salmon are short-lived species (generally two to three years) that reproduce only once shortly before dying. Spawning escapements of coho salmon are dominated by a single year class. The abundance of year classes can fluctuate dramatically with combinations of natural and human-caused environmental variation. General life history information for coho salmon (*Oncorhynchus kisutch*) is summarized below, followed by information on population trends for each coho salmon ESU. Further detailed information on these coho salmon ESUs are available in the NMFS Status Review of coho salmon from Washington, Oregon, and California (Weitkamp et al. 1995), the NMFS proposed rule for listing coho (60 FR 38011, July 25, 1995), and in the references sited in Table 2.

Adult Freshwater Migration and Spawning: Most coho salmon adults are 3 years old, having spent approximately 18 months in freshwater and 18 months in salt water. Wild female coho return to spawn almost exclusively at age 3, and in the absence of overlapping maternal generations, the separate maternal brood lineages are at high risk from the effects of catastrophic events such as floods or dewaterings due to drought or water diversions. An exception to this pattern are "jacks," which are sexually mature males that return to freshwater to spawn after only 5-7 months in the ocean. Most west coast coho salmon enter rivers in October and spawn from November to December and occasionally into January. However, both run and spawn-timing of Central California coho salmon are very late (peaking in January) with little time spent in freshwater between river entry and spawning. This compressed adult freshwater residency appears to coincide with the single, brief peak of river flow characteristic of this area. Many small California systems have sandbars which block their mouths for most of the year except during winter. In these systems, coho salmon and other salmon species are unable to enter the rivers until sufficiently strong freshets break the sandbars (Gilbert 1912; Pritchard 1940; Marr 1943; Briggs 1953; Shapovalov and Taft 1954; Foerster 1955; Milne 1957; Salo and Bayliff 1958; Loeffel and Wendler 1968; Wright 1970; Sandercock 1991).

While central California coho spend little time between river entry and spawning, northern stocks may spend 1 or 2 months in fresh water before spawning (Flint and Zillges 1980, Fraser et al. 1983). In larger river systems like the Klamath River, coho salmon have a broad period of freshwater entry spanning from August until December (Leidy and Leidy 1984). In general, earlier migrating fish spawn farther upstream within a basin than later migrating fish, which enter rivers in a more advanced state of sexual maturity (Sandercock 1991).

Juvenile Rearing and Outmigration: Coho salmon fry usually emerge from the gravel at night from March to May. Coho salmon fry begin feeding as soon as they emerge from the gravel, and grow rapidly. In California, fry move into deep pools in July and August, where feeding is reduced and growth rate decreased (Shapovalov and Taft 1954). Between December and February, winter rains result in increased stream flows and by March, following peak flows, fish feed heavily again on insects and crustaceans and grow rapidly.

Peak outmigration timing generally occurs in May, about a year after emergence from the gravel. In California, smolts migrate to the ocean somewhat earlier, from mid-April to mid-May. Most smolts measure 90-115 mm, although Klamath River Basin tend to be larger, but this is possibly due to influences of off-station hatchery plants.

C. Population Dynamics and Distribution

1. Chinook Salmon

Puget Sound Chinook: This ESU encompasses all runs of chinook salmon in the Puget Sound region from the North Fork Nooksack River in the east to the Elwha River on the Olympic Peninsula. Chinook salmon in this area all exhibit an ocean-type life history. Although some spring-run chinook salmon populations in the Puget Sound ESU have a high proportion of yearling smolt emigrants, the proportion varies substantially from year to year and appears to be environmentally mediated rather than genetically determined. Puget Sound stocks all tend to mature at ages 3 and 4 and exhibit similar, coastally-oriented, ocean migration patterns.

The 5-year geometric mean of spawning escapement of natural chinook salmon runs in North Puget Sound for 1995-99 is approximately 18,000. Although long- and short-term trends for these runs were predominately negative, the North Fork Nooksack, Stillaguamish and Snohomish systems have shown improvements in escapements since 1996[1] (NMFS 2000a). In South Puget Sound and Hood Canal, the 5-year geometric mean of spawning escapement of the natural runs has averaged 13,000 spawners (NMFS 2000a). In this area, both long- and short-term trends are predominantly positive, however, the contribution of hatchery fish to natural escapements in this region may be substantial, masking the trends in natural production. Research projects are underway to determine the degree of hatchery contributions to natural escapements, and the amount of natural production.

Puget Sound chinook is the largest and most complex ESU that is considered in detail in this opinion. WDF et al. (1993) identified 28 stocks that were distributed among five geographic regions and 14 management units or basins (NMFS 2000a). (The Hoko River stock was included in the initial inventory, but was subsequently assigned to the neighboring ESU.) NMFS is currently engaged in delineating the population structure of PS chinook and other ESUs as an initial step in a formal recovery planning effort that is now underway. These determinations have not been finalized at this time, but it is clear that these 28 stocks represent the greatest level of potential stratification and that some further aggregation of these stocks is likely (M. Ruckelshaus, NWFSC/NMFS, pers. com. to S. Bishop, NMFS, March 21, 2000). By considering at this time the status of the stocks as described by WDF et al. 1993, NMFS can be reasonably certain that we are not overlooking population structures that may be important to the ESU.

Puget Sound includes areas where the habitat still supports self-sustaining natural production of chinook, areas where habitat for natural production has been irrevocably lost, and areas where chinook salmon were never self-sustaining. In some areas indigenous local stocks persist, whereas local stocks in other areas are a composite of indigenous stocks and introduced hatchery

[1] NMFS' status review of west coast chinook (Meyers et al. 1999), including stocks within the Puget Sound ESU, was completed in 1997, and therefore, only considered escapements through 1996.

fish that may or may not be of local origin. In some areas where natural production has been lost, hatchery production has been used to mitigate for lost natural production. In response to these varied circumstances, the state and tribal co-managers have developed a proposal to stratify stocks to provide a context for analyzing actions and considering recovery efforts. This stratification was initially proposed in conjunction with a now ongoing consultation regarding hatchery activities in Puget Sound. However, the proposal is broadly applicable and used in this consultation as well, thus providing a common framework for analyzing both harvest and hatchery activities. Although this stratification scheme has not been formally adopted by the co-managers, it nonetheless provides a useful construct for analysis.

The stratification assigns stocks to one of three categories:

Category 1 stocks are genetically unique and indigenous to watersheds of Puget Sound. Maintaining genetic diversity and integrity of these stocks and achieving abundance levels for long-term sustainability is the highest priority for these stocks. Nineteen stocks have been identified in this category (NMFS 2000a).

The status of these stocks varies. Some stocks (Dungeness and Nooksack) have fallen to such low levels that our ability to maintain their genetic diversity may be at risk. Other stocks are more robust and the abundance levels are above what is needed to sustain genetic diversity, but often not at levels that will sustain maximum yield harvest rates. All of these stocks have natural spawning escapement goals, which are actively managed for, but have not generally been achieved in recent years. In some cases (Elwha, Dungeness, Nooksack, Stillaguamish, and White River) hatchery operations are essential for recovery, and without them, the stocks would likely further decline and become extinct. In one case at least (Green River) the number of hatchery fish spawning naturally is a concern, in part, because it masks our ability to evaluate the actual productivity of wild fish. The objective for category 1 stocks is to protect and recover these indigenous stocks.

Category 2 stocks are located in watersheds where indigenous stocks may no longer exist, but where sustainable stocks existed in the past and where the habitat could still support such stocks. These are primarily areas in Hood Canal and South Sound where hatchery production has been used to mitigate for natural production lost to habitat degradation. Consequently, these areas have been managed for hatchery production and harvest for many years. Natural spawning in these systems continues, but is primarily the result of hatchery-origin strays. Stocks have been preliminarily assigned to Category 2 based on current information, but further investigations will seek to identify remnant indigenous stocks, which, if found, would cause them to be reassigned to Category 1. The objective for Category 2 stocks is to use the most locally-adaptable stock to reestablish naturally-sustainable populations.

Category 3 stocks are generally found in small independent tributaries of Puget Sound that may now have some spawning, but never had independent, self-sustaining stocks of chinook salmon. Many of these watersheds do not have the morphological characteristics needed for chinook and may be better suited for coho and chum salmon, cutthroat trout or resident species. Chinook salmon that are observed occasionally in these watersheds are primarily the result of hatchery strays. The objective for these systems is directed at habitat protection to ensure the production of other species, but no specific actions are proposed to promote the natural production of chinook salmon. For further discussion regarding the status of the component populations, see the references cited in Table 2.

Snake River Spring/Summer Chinook: The present range of spawning and rearing habitat for naturally-spawned Snake River spring/summer chinook salmon is primarily limited to the Salmon, Grande Ronde, Imnaha, and Tucannon Subbasins. Most Snake River spring/summer chinook salmon enter individual subbasins from May through September. Juvenile Snake River spring/summer chinook salmon emerge from spawning gravels from February through June (Perry and Bjornn 1991). Typically, after rearing in their nursery streams for about one year, smolts begin migrating seaward in April and May (Bugert et al. 1990; Cannamela 1992). After reaching the mouth of the Columbia River, spring/summer chinook salmon probably inhabit nearshore areas before beginning their northeast Pacific Ocean migration, which lasts two to three years. Because of their timing and ocean distribution, these stocks are subject to very little ocean harvest. For detailed information on the life history and stock status of Snake River spring/summer chinook salmon, see Matthews and Waples (1991), NMFS (1991a), and 56 FR 29542 (June 27, 1991).

Bevan et al. (1994) estimated the number of wild adult Snake River spring/summer chinook salmon in the late 1800s to be more than 1.5 million fish annually. By the 1950s, the population had declined to an estimated 125,000 adults. Escapement estimates indicate that the population continued to decline through the 1970s. Returns were variable through the 1980s, but declined further in recent years. Record low returns were observed in 1994 and 1995. Dam counts were modestly higher from 1996-1998, but declined in 1999. For management purposes the spring and summer chinook in the Columbia Basin, including those returning to the SR, have been managed as separate stocks. Historic databases therefore provide separate estimates for the spring and summer chinook components. Table 3 reports the estimated annual return of adult, natural-origin SR spring and summer chinook salmon returning to Lower Granite Dam since 1979. A preliminary estimated of the recovery escapement goal for SR spring/summer chinook of 31,440 (counted at Ice Harbor Dam) was suggested in NMFS' Proposed Recovery Plan (NMFS 1995).

Table 3. Estimates of natural-origin Snake River spring/summer chinook salmon counted at Lower Granite Dam in recent years (Speaks 1999).

| Year | Spring Chinook | Summer Chinook | Total |
|---|---|---|---|
| 1979 | 2,573 | 2,712 | 5,285 |
| 1980 | 3,478 | 2,688 | 6,166 |
| 1981 | 7,941 | 3,326 | 11,267 |
| 1982 | 7,117 | 3,529 | 10,646 |
| 1983 | 6,181 | 3,233 | 9,414 |
| 1984 | 3,199 | 4,200 | 7,399 |
| 1985 | 5,245 | 3,196 | 8,441 |

| Year | Spring Chinook | Summer Chinook | Total |
|---|---|---|---|
| 1986 | 6,895 | 3,934 | 10,829 |
| 1987 | 7,883 | 2,414 | 10,297 |
| 1988 | 8,581 | 2,263 | 10,844 |
| 1989 | 3,029 | 2,350 | 5,379 |
| 1990 | 3,216 | 3,378 | 6,594 |
| 1991 | 2,206 | 2,814 | 5,020 |
| 1992 | 11,285 | 1,148 | 12,433 |
| 1993 | 6,008 | 3,959 | 9,967 |
| 1994 | 1,416 | 305 | 1,721 |
| 1995 | 745 | 371 | 1,116 |
| 1996 | 1,358 | 2,129 | 3,487 |
| 1997 | 1,434 | 6,458 | 7,892 |
| 1998 | 5,055 | 3,371 | 8,426 |
| 1999 | 1,433 | 1,843 | 3,276 |
| Recovery Esc Level (counted at Ice Harbor) | | | 31,440 |

The Snake River spring/summer chinook salmon ESU consists of 39 local spawning populations (subpopulations) spread over a large geographic area (Lichatowich et al. 1993). The number of fish returning to Lower Granite Dam is therefore divided among these subpopulations. The relationship between these subpopulations, and particularly the degree to which straying may occur between these is unknown. It is unlikely that these are all "populations" as defined by McElhany et al (1999) which requires that they be isolated to the extent that the exchange of individuals among the populations does not substantially affect the population dynamics or extinction risk over a 100-year time frame. Nonetheless, monitoring the status of the subpopulations provides a more detailed indicator of the species' status than does the general measure of aggregate abundance. For further discussion see references cited in Table 2.

Upper Columbia River Spring Chinook: The UCR spring chinook ESU inhabits tributaries upstream from the Yakima River to Chief Joseph Dam. Upper Columbia River spring chinook have a stream-type life history. Adults return to the Wenatchee River from late March to early May, and from late March to June in the Entiat and Methow rivers. Most adults return after spending two years in the ocean, while 20%-40% return after three years at sea. Like the SR spring/summer chinook, UCR spring chinook are subject to very little ocean harvest. Peak spawning for all three populations occurs from August to September. Smolts typically spend one year in freshwater before migrating downstream. This ESU has slight genetic differences from other ESUs containing stream-type fish, but more importantly it has ecological differences in spawning and rearing habitats that were used to define the ESU boundary (Myers et al. 1998). The Grand Coulee Fish Maintenance Project (1939-1943) was also a major influence on this

ESU because fish from multiple populations were mixed into one relatively homogenous group and redistributed into streams throughout the Upper Columbia Region.

Three independent populations of spring chinook salmon are identified for the ESU including those that spawn in the Wenatchee, Entiat and Methow River basins (McElhany et al. 1999). Trends for these populations have generally been declining. The number of natural-origin fish returning to each of the subbasins is shown in Table 4. These can be compared to Recovery Abundance Levels and Cautionary Levels that have recently been proposed (although still under review and subject to change (Quantitative Analytical Report, T. Cooney, NMFS, pers. comm. w/ P. Dygert, NMFS, January 21, 2000). The Cautionary Levels are characterized as abundance levels below which historically the population would be expected to fall only about 10% of the time. Escapements consistently below these levels indicate increasing risk and uncertainty about population status. Escapements in recent years have been substantially below the Cautionary levels. Escapements in 1995 were particularly low. The primary return year for the 1995 brood is 1999. The preliminary return estimates for the 1999 escapement indicates that the returns were low, but still substantially above the brood year replacement levels. The very strong jack returns in 1999 and 2000 suggest that survival rates for the 1996 and 1997 brood years will be relatively high. For further discussion see references cited in Table 2.

Table 4. Estimates of the number of natural-origin fish returning to the sub-basin for each of the identified UCR spring chinook populations and preliminary estimates for the Recovery Abundance and Cautionary Levels. Estimates for 2000 are preliminary.

| Year | Wenatchee River | Entiat River | Methow River |
|---|---|---|---|
| 1979 | 1,154 | 241 | 554 |
| 1980 | 1,752 | 337 | 443 |
| 1981 | 1,740 | 302 | 408 |
| 1982 | 1,984 | 343 | 453 |
| 1983 | 3,610 | 296 | 747 |
| 1984 | 2,550 | 205 | 890 |
| 1985 | 4,939 | 297 | 1,035 |
| 1986 | 2,908 | 256 | 778 |
| 1987 | 2,003 | 120 | 1,497 |
| 1988 | 1,832 | 156 | 1,455 |
| 1989 | 1,503 | 54 | 1,217 |
| 1990 | 1,043 | 223 | 1,194 |
| 1991 | 604 | 62 | 586 |
| 1992 | 1,206 | 88 | 1,719 |

| Year | Wenatchee River | Entiat River | Methow River |
|---|---|---|---|
| 1993 | 1,127 | 265 | 1,496 |
| 1994 | 308 | 74 | 331 |
| 1995 | 50 | 6 | 33 |
| 1996 | 201 | 28 | 126 |
| 1997 | 422 | 69 | 247 |
| 1998 | 218 | 52 | 125 |
| 1999 | 119 | 64 | 73 |
| *2000* | *489* | *175* | *<75* |
| **Recovery Abundance** | **3,750** | **500** | **2,000** |
| **Cautionary Abundance** | **1,200** | **150** | **750** |

Snake River Fall Chinook: The spawning grounds between Huntington (RM 328) and Auger Falls (RM 607) were historically the most important for this species. Only limited spawning activity was reported downstream from RM 273 (Waples, et al. 1991), about one mile upstream of Oxbow Dam. Since then, irrigation and hydropower projects on the mainstem Snake River have blocked access to or inundated much of this habitat, causing the fish to seek out less-preferable spawning grounds wherever they are available. Natural fall chinook salmon spawning now occurs primarily in the Snake River below Hells Canyon Dam and the lower reaches of the Clearwater, Grand Ronde, Salmon, and Tucannon Rivers.

Adult Snake River fall chinook salmon enter the Columbia River in July and migrate into the Snake River from August through October. Fall chinook salmon generally spawn from October through November and fry emerge from March through April. Downstream migration generally begins within several weeks of emergence (Becker 1970, Allen and Meekin 1973), and juveniles rear in backwaters and shallow water areas through mid-summer prior to smolting and migrating to the ocean thus they exhibit an "ocean" type juvenile history. Once in the ocean, they spend one to four years (though usually, three) before beginning their spawning migration. Fall returns in the Snake River system are typically dominated by four-year-old fish. For detailed information on the Snake River fall chinook salmon, see NMFS (1991b) and June 27, 1991 (56 FR 29542).

No reliable estimates of historical abundance are available, but because of their dependence on mainstem habitat for spawning, fall chinook have probably been impacted to a greater extent by the development of irrigation and hydroelectric projects than any other species of salmon. It has been estimated that the mean number of adult Snake River fall chinook salmon declined from 72,000 in the 1930s and 1940s to 29,000 during the 1950s. In spite of this, the Snake River remained the most important natural production area for fall chinook in the entire Columbia River basin through the 1950s. The number of adults counted at the uppermost Snake River mainstem dams averaged 12,720 total spawners from 1964 to 1968, 3,416 spawners from 1969 to 1974, and

610 spawners from 1975 to 1980 (Waples, et al. 1991).

Counts of adult fish of natural-origin continued to decline through the 1980s, reaching a low of 78 individuals in 1990. Since then the return of natural-origin fish to Lower Granite Dam (LGD) has been variable, but generally increasing, reaching a recent year high of 905 in 1999. The five year average return has increased from 419 for the 1990-1994 time frame to 599 since 1995 (NMFS 2000b).

These returns can be compared to the previously identified lower abundance threshold of 300 and the recovery escapement goal of 2,500 which are the kinds of benchmarks suggested in the Viable Salmonid Populations paper (McElhany et al. 1999) for evaluating population status. The lower threshold is considered indicative of increased relative risk to a population in the sense that the further and longer a population is below the threshold the greater the risk; it was clearly not characterized as a "redline" below which a population must not go (BRWG 1994). The recovery standard that was initially identified in the 1995 BiOp for Snake River fall chinook was a population of at least 2,500 naturally produced spawners (to be calculated as an eight year geometric mean) in the lower Snake River and its tributaries. The LGD counts can not be compared directly to the natural spawner escapement objective since it is also necessary to account for adults which may fall back below the dam after counting and prespawning mortality. A preliminary estimate suggested that a LGD count of 4,300 would be necessary to meet the 2,500 fish escapement goal (NMFS 1995). Recent escapements have clearly been well below this goal, but they have also been consistently above the lower abundance threshold and generally increasing in recent years. For further discussion see the references cited in Table 2.

<u>Lower Columbia River Chinook:</u> The LCR ESU includes spring stocks and fall tule and bright components. The abundance of fall chinook greatly exceeds that of the spring component. Spring-run chinook salmon on the lower Columbia River, like those from coastal stocks, enter freshwater in March and April well in advance of spawning in August and September. Historically, fish migrations were synchronized with periods of high rainfall or snow melt to provide access to upper reaches of most tributaries where spring stocks would hold until spawning (Fulton 1968, Olsen et al. 1992, WDF et al. 1993). Fall run fish do not begin entry to the Columbia River until at least August and so are not affected by the actions being considered here.

The remaining spring chinook stocks in the LCR ESU are found in the Sandy on the Oregon side and Lewis, Cowlitz, and Kalama on the Washington side. Spring chinook in the Clackamas River are considered part of the UWR ESU. Naturally spawning spring chinook in the Sandy River are included in the LCR ESU despite substantial influence of Willamette hatchery fish from past years since they likely contain all that remains of the original genetic legacy for that system. Recent escapements above Marmot Dam on the Sandy River average 2,800 and have been increasing (ODFW 1998b). Hatchery-origin spring chinook are no longer released above Marmot Dam; the proportion of first generation hatchery fish in the escapement is relatively low, on the order of 10-20% in recent years.

On the Washington side spring chinook were present historically in the Cowlitz, Kalama, and Lewis rivers. Spawning areas were blocked by dam construction in the Cowlitz and Lewis. The native Lewis run became extinct soon after completion of Merwin Dam in 1932. Production in the Kalama was limited by dams and by 1950 only a remnant population remained. Spring chinook in the Cowlitz, Kalama, and Lewis are currently all hatchery fish. There is some natural spawning in the three rivers, but these are believed to be primarily from hatchery strays (ODFW 1998b). The recent averages (1994-1998) for naturally spawning spring chinook in the Cowlitz, Kalama, and Lewis are 235, 224, and 372, respectively. The amount of natural production resulting from these escapements is unknown, but is presumably small since the remaining habitat in the lower rivers is not the preferred habitat for spring chinook. The Lewis and Kalama hatchery stocks have been mixed with out-of-basin stocks, but are nonetheless included in the ESU. The Cowlitz stock is largely free of introductions and is considered essential for recovery although not listed. The number of spring chinook returning to the Cowlitz, Kalama, and Lewis rivers have declined in recent years, but still number several hundred to a few thousand in each system. Hatchery escapement goals have been consistently met in the Cowlitz and Lewis Rivers. The goal has not been met in all years in the Kalama, but WDFW continues to use brood stock from the Lewis to meet production goals in the Kalama. Although the status of hatchery stocks are not always a concern or priority from an ESA perspective, in situations where the historic spawning habitat is no longer accessible, the status of the hatchery stocks is pertinent. The expected returns in 2000 exceed escapement objectives for each of the three Washington tributary systems.

There are apparently three self-sustaining natural populations of tule chinook in the Lower Columbia River (Coweeman, East Fork Lewis, and Clackamas) that are not substantially influenced by hatchery strays. Returns to the East Fork and Coweeman have been stable and near interim escapement goals in recent years. Recent 5 and 10 year average escapements to the East Fork Lewis have been about 300 compared to an interim escapement goal of 300. Recent 5 and 10 year average escapements to the Coweeman are 900 and 700, respectively, compared to an interim natural escapement goal of 1000 (pers. comm., from G. Norman, WDFW to P. Dygert NMFS, February 22, 1999). Natural escapement on the Clackamas has averaged about 350 in recent years. There have been no releases of hatchery fall chinook in the Clackamas since 1981 and there are apparently few hatchery strays. The population is considered depressed, but stable and self-sustaining (ODFW 1998b). There is some natural spawning of tule fall chinook in the Wind and Little White Salmon Rivers, tributaries above Bonneville Dam (the only component of the ESU that is affected by tribal fisheries). Although there may be some natural production in these systems, the spawning results primarily from hatchery-origin strays.

The LCR bright stocks are among the few healthy natural chinook stocks in the Columbia River Basin. Escapement to the North Fork Lewis River has exceed its escapement goal of 5,700 by a substantial margin every year since 1980, with a recent five year average escapement of 10,000. The forecast in 1999 was for an exceptionally low return of about 2,500. The actual return was about 3,300. Preliminary information suggests that the escapement in 2000 will again be substantially above the escapement goal.

<u>Upper Willamette River Chinook</u>: UWR chinook are one of the most genetically distinct groups of chinook in the Columbia River Basin. This may be related in part to the narrow time window available for passage above Willamette Falls. Chinook populations in this ESU have a life history pattern that includes traits from both ocean- and stream-type life histories. Smolt emigrations occur as young of the year and as age-1 fish. Ocean distribution of chinook in this ESU is consistent with an ocean-type life history with the majority of chinook being caught off the coasts

of British Columbia and Alaska. Spring chinook from the Willamette River have the earliest return timing of chinook stocks in the Columbia Basin with freshwater entry beginning in February. Historically, spawning occurred between mid-July and late October. However, the current spawn timing of hatchery and wild chinook in September and early October likely is due to hatchery fish introgression.

The abundance of naturally-produced spring chinook in the ESU has declined substantially from historic levels. Historic escapement levels may have been as high as 200,000 fish. The production capacity of the system has been reduced substantially by extensive dam construction and habitat degradation. From 1946-50, the geometric mean of Willamette Falls counts for spring chinook was 31,000 fish (Myers et al. 1998), which represented primarily naturally-produced fish. The most recent 5 year (1995-1999) geometric mean escapement above the falls was 27,800 fish, comprised predominantly of hatchery-produced fish (NMFS 2000c). Nicholas (1995) estimated 3,900 natural spawners in 1994 for the ESU, with approximately 1,300 of these spawners being naturally produced. There has been a gradual increase in naturally spawning fish in recent years, but it is believed that many of these are first generation hatchery fish. The long-term trend for total spring chinook abundance within the ESU has been approximately stable although there was a series of higher returns in the late-80s and early-90s that are associated with years of higher ocean survival. The great majority of fish returning to the Willamette River in recent years have been of hatchery-origin.

Historically, there were five major basins that produced spring chinook including the Clackamas, North and South Santiam Rivers, McKenzie, and the Middle Fork Willamette. However, between 1952-1968 dams were built on all of the major tributaries occupied by spring chinook, blocking over half of the most important spawning and rearing habitat. Dam operations have also reduced habitat quality in downstream areas due to thermal and flow effects. Dams on the South Fork Santiam and Middle Fork Willamette eliminated wild spring chinook in those systems (ODFW 1997). Although there is still some natural spawning in these systems below the dams, habitat quality is such that there is probably little resulting production and the spawners are likely of hatchery origin. Populations in several smaller tributaries that also used to support spring chinook are believed to be extinct (Nicholas 1995).

The available habitat in the North Fork Santiam and McKenzie rivers was reduced to 1/4 and 2/3, respectively, of its original capacity. Spring chinook on the Clackamas were extirpated from the upper watershed after the fish ladder at Faraday Dam washed out in 1917, but recolonized the system after 1939 when the ladder was repaired. NMFS was unable to determine, based on available information whether this represents a historical affinity or a recent, human-mediated expansion into the Clackamas River. Regardless, NMFS included natural-origin spring chinook as part of the listed populations and considers Clackamas spring chinook as a potentially important genetic resource for recovery.

The McKenzie, Clackamas, and North Santiam are therefore the primary basins that continue to support natural production. Of these the McKenzie is considered the most important. Prior to construction of major dams on Willamette tributaries, the McKenzie produced 40% of the spring chinook above Willamette Falls and it may now account for half the production potential in the Basin. Despite dam construction and other habitat degradations, the McKenzie still supports substantial production with most of the better quality habitat located above Leaburg Dam. The interim escapement objective for the area above the Dam is 3,000-5,000 spawners (ODFW 1998a). Pristine production in that area may have been as high as 10,000, although substantial habitat improvements would be required to again achieve pristine production levels. Estimates of the number of natural-origin spring chinook returning to Leaburg Dam are available since 1994 when adults from releases of hatchery reared smolts above the dam were no longer present. The number of natural-origin fish at the Dam has increased steadily from over 800 in 1994 to about 1,400 in 1998 and 1999. Additional spawning in areas below the Dam accounts for about 20% of the McKenzie return. For further discussion see references cited in Table 2.

<u>California Coastal Chinook</u>: Coastal California streams support small, sporadically monitored populations of fall-run chinook salmon. Chinook occur in relatively low numbers in northern streams, and their abundance is sporadic in streams in the southern portion of the geographic region encompassing this ESU. Estimates of absolute population abundance are not available for most populations in this ESU. Coastal chinook are highly dependent upon seasonal rainfall and stream flows in ascending tributaries to spawn; fish may spawn in the main stems of rivers if they do not have access into tributaries. As a result, many of the index counts available for Coastal chinook may be reflective of flow conditions rather than population trends. Where available, surveys of coastal chinook spawner abundance in some cases show improvement relative to the extremely low escapements of the early 90s; other streams, such as Tomki Creek remain extremely depressed (Figure 1). Hatchery chinook salmon occur in the Russian and North Fork Mad rivers, but the contribution of hatchery fish to natural spawning escapements is not known (Myers et al. 1998).

California coastal chinook are listed as threatened as a result of the habitat blockages, logging and agricultural activities, urbanization and water withdrawals in the river drainages that support California coastal salmon. These have resulted in widespread declines in abundance of chinook relative to historical levels and the present distribution of small populations with sporadic occurrences. Smaller coastal drainages such as the Noyo, Garcia and Gualala rivers may have supported chinook salmon runs historically, but they contain few or no fish today. The Russian River probably contains some natural production, but the origin of those fish is not clear because of a number of introductions of hatchery fish over the last century. The Eel River contains a substantial fraction of the remaining chinook salmon spawning habitat within the ESU (CDFG 1965).

<u>Central Valley Spring Chinook</u>: Historically, spring chinook were most abundant in the San Joaquin Basin and the dominant run in both the Sacramento and San Joaquin River systems (Clark, 1929; Fry 1961). Native populations in the San Joaquin River have apparently all been extirpated (Campbell and Moyle, 1990). Clark (1929) estimated that there were historically 6,000 stream miles of salmonid habitat in the Sacramento-San Joaquin River Basin, but only 510 miles remained by 1928. Subsequently, elimination of access to spawning and rearing habitat resulting from construction of impassable dams has extirpated spring chinook from the San Joaquin River Basin and the American River. Construction of impassable dams has also curtailed access to habitat in the upper Sacramento and Feather rivers.

Calkins et al. (1940) estimated a spawning escapement of 38,792 spring chinook for the

Sacramento River based on fishery landings. In the mid-1960s, CDFG (1965) estimated total spawning escapement of spring-run chinook salmon to be 28,500, with the majority (15,000) spawning in the mainstem Sacramento River and the remainder scattered among Battle, Cottonwood, Antelope, Mill, Deer, Big Chico, and Butte Creeks and the Feather River. CDFG (1965) reported spring-run chinook salmon to be extinct in the Yuba, American, Mokelumne,

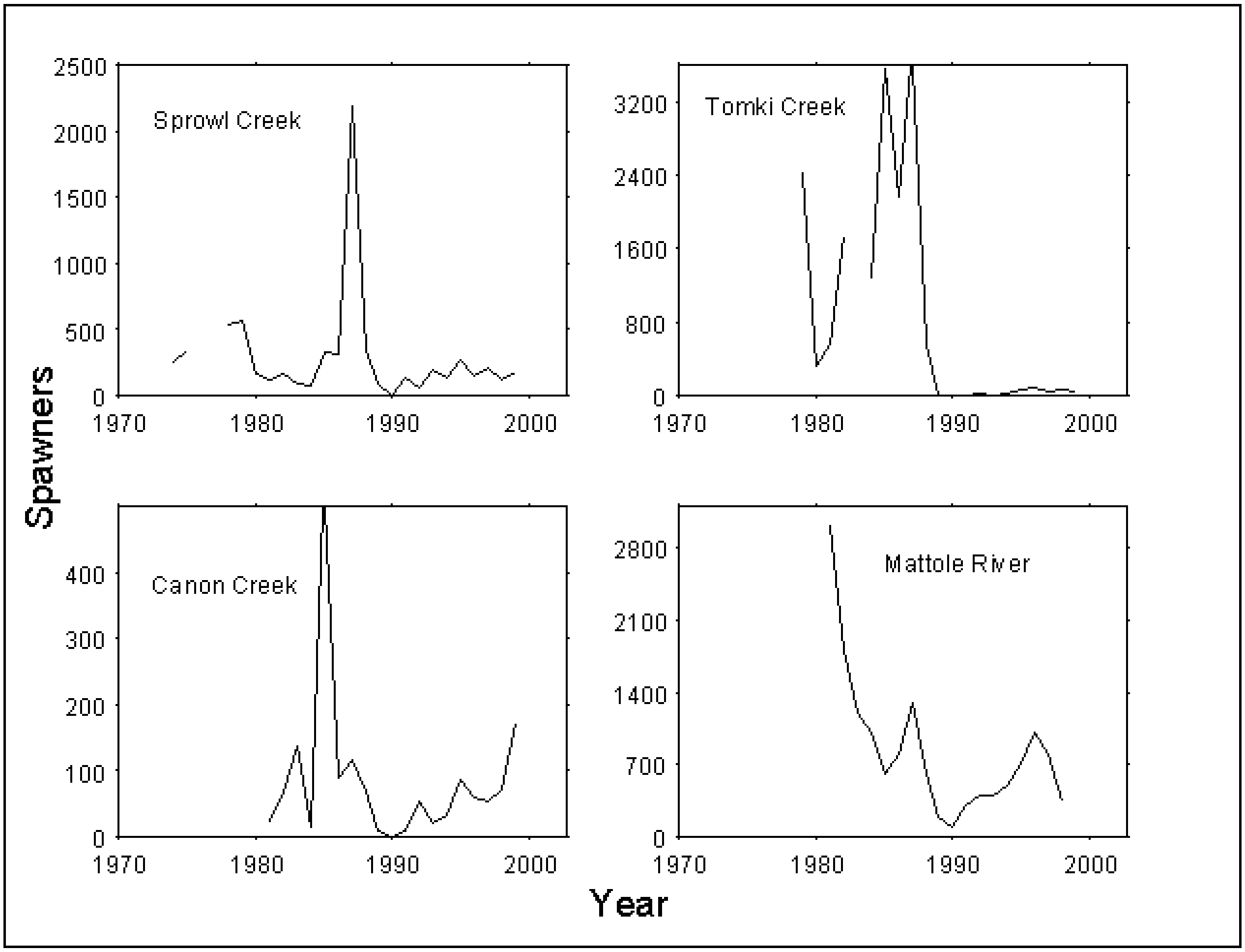



**Figure 1** Estimates of chinook spawning abundance in the Mattole River and tributaries to the Eel River (Sprowl and Tomki creeks) and Mad River (Canon Creek). Survey area for Canon Creek is from mouth to falls (2 miles); survey area for Sprowl Creek is the main stem and West Fork; estimate for Tomki Creek is the total run size including jacks. (PFMC 2000 and the Mattole Salmon Group).

Stanislaus, Tuolumne, Merced, and San Joaquin Rivers. Today, spawner survey data are available for the mainstem Sacramento River, Feather River, Butte Creek, Deer Creek and Mill Creek. Small populations are also reported in Antelope, Battle, Cottonwood, and Big Chico Creeks. The Butte Creek population is genetically distinct from the Deer and Mill Creek populations, returning earlier and spawning at lower elevations (Myers et al., 1998). Sacramento River mainstem spawners have declined sharply since the mid-1980s, from 5,000-15,000 to a few hundred fish, and are believed to have hybridized with the fall run (Myers et al., 1998).

The long term abundance trends for the Mill, Deer, and Butte creek populations are negative (Myers et al., 1998), however since 1991 these populations have been increasing. Population trends can be evaluated by examining cohort return rates, defined as the number of females in a given cohort that return to spawn divided by the number of females that produced the cohort. Such a calculation requires data on age structure and sex ratio of returning adults. The abundance estimates of Central Valley spring chinook populations do not permit the calculation of cohort replacement rates. However, an estimate of the relative strength of brood year lineages can be made by assuming that the majority of spawning adults return at age 3 and there is a 1:1 sex ratio. To the extent that these assumptions are true, three year replacement rates, calculated as the adult escapement in year n divided by the adult escapement in year n-3, are indicators of the cohort replacement rate. Three year replacement rates of less than 1.0 indicate the population is declining; rates of 1.0 or greater mean the population is stable or growing.[2] Table 5 shows spawner estimates and 3 year replacement rates for spring chinook populations in Deer, Mill, and Butte Creeks and for Sacramento River winter chinook, which were listed as threatened in 1989 and reclassified as threatened in 1994.

**Table 5.** Total spawning escapement and three year replacement rates of spring chinook and Sacramento River winter chinook (SRWC) (from CDFG, 1998; Colleen Harvey-Arrison, CDFG, personal communication).

| Year | Mill Creek | 3Y RR | Deer Creek | 3Y RR | Butte Creek | 3Y RR | SRWC[1] | 3Y RR |
|---|---|---|---|---|---|---|---|---|
| 1987 | 89 | | 200 | | 14 | | 1,761 | |
| 1988 | 572 | | 371 | | 1300 | | 1,386 | |
| 1989 | 561 | | 77 | | 1300 | | 480 | |
| 1990 | 844 | 9.49 | 458 | 2.29 | 100 | 7.14 | 425 | 0.24 |
| 1991 | 319 | 0.56 | 448 | 1.21 | 100 | 0.08 | 134 | 0.10 |
| 1992 | 237 | 0.42 | 209 | 2.71 | 730 | 0.56 | 1,122 | 2.34 |
| 1993 | 61 | 0.07 | 259 | 0.57 | 650 | 6.50 | 267 | 0.63 |
| 1994 | 723 | 2.27 | 485 | 1.08 | 474 | 4.74 | 153 | 1.14 |
| 1995 | 320 | 1.35 | 1,295 | 6.20 | 7,500 | 10.27 | 1,296 | 1.16 |
| 1996 | 252 | 4.13 | 614 | 2.37 | 1,413 | 2.17 | 612 | 2.29 |
| 1997 | 200 | 0.28 | 466 | 0.96 | 635 | 1.34 | 480 | 3.14 |
| 1998 | 424 | 1.33 | 1,879 | 1.45 | 20,212 | 2.40 | 1,784 | 1.38 |
| 1999 | 560 | 2.22 | 1,591 | 2.59 | 3,000 | 2.12 | 885 | 1.45 |
| Mean 3YRR 1994-1999 | | 1.47 | | 1.96 | | 3.05 | | 1.75 |

1. Adult spawners

Since 1994, 3 year replacement rates have generally been greater that one. The geometric mean of the 3 year replacement rates for the most recent 6 years are 1.47, 1.96, and 3.05 for the Mill, Deer, and Butte Creek populations respectively.

Spring chinook are listed as threatened because they presently have access to a small fraction (perhaps 10% or less) of their historic spawning habitat and the habitat remaining to them is degraded. In addition, they face hostile downstream conditions in the mainstem Sacramento River and the Sacramento-San Joaquin Delta, they are caught in ocean and freshwater fisheries and they may be subject to the adverse genetic affects of straying hatchery populations such as Feather River Hatchery spring chinook.

Spring chinook historically occupied the upper reaches of all major tributaries to the Sacramento and San Joaquin rivers. Of the 21 populations identified by the California Department of Fish and Game in their status review (CDFG 1998) only 3 self-sustaining populations now exist in the upper Sacramento in Deer, Mill and Butte Creeks. Although these streams have not been affected by large impassable dams, diversions and small dams have degraded the spawning habitat.

Since 1993, spring chinook populations have increased in abundance. The factors responsible for

[2]Interpretation of the causes of the apparent increases in three year replacement rates is complicated by changes in ocean harvest regimes that may have resulted in a shift of part of the total brood year production from ocean harvest to spawning escapement.

these increases likely include adequate rainfall, improvements in fresh water spawning and migration habitat, as well as the reduction in harvest rates on Central Valley chinook during the last three years. The California Department of Fish and Game (CDFG 1993a) estimated that Deer Creek has sufficient habitat to support "sustainable populations" of 4,000 spring chinook; 1,900 and 1,500 spawners returned in 1998 and 1999 respectively. Efforts to restore salmon habitat in Butte Creek have been underway for the past decade. Over 20,000 spring chinook returned to Butte Creek in 1998 and 3,000 in 1999. Both years represent greater than two fold increases in the three-year replacement rate.

Sacramento winter chinook run: The four Central Valley chinook salmon races (winter, spring, fall and late-fall) are named on the basis of their upstream migration time and defined by adult migration timing, spawning period, length of juvenile residency and timing of smolt migration. Winter chinook are unique to the Central Valley; no other chinook salmon populations have a similar life-history pattern (Healey 1991). In general, winter chinook exhibit an ocean-type life-history strategy, with smolts emigrating to the ocean after five to nine months of freshwater residence and remaining near the coasts of California and Oregon (Myers et al. 1998). Winter chinook mature at a relatively young age (2-3 years old). DNA analysis indicates substantial genetic differences between the winter run and other runs of chinook salmon in the Sacramento River (Banks et al. 2000).

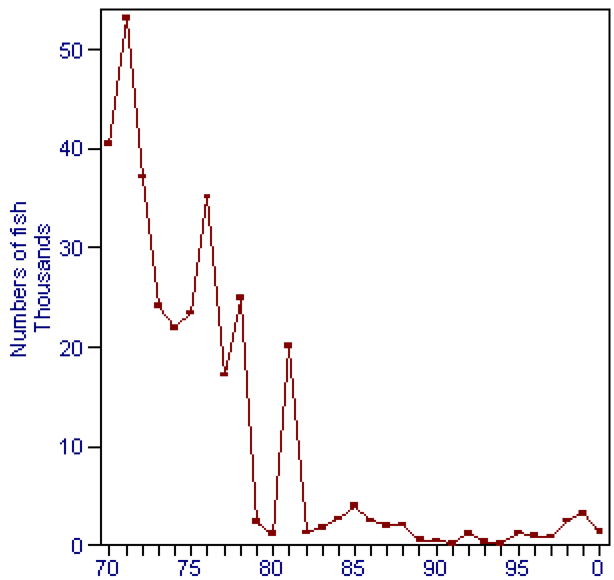
The spawning period of winter chinook generally extends from mid-April to mid-August with peak activity occurring in June. The emigration of juvenile winter chinook from the upper Sacramento River is highly dependent on flow conditions. Once fry have emerged, storm events may cause emigration pulses. Emigration past Red Bluff may begin as early as late July, generally peaks in September, and can continue until mid-March in drier years (Vogel and Marine 1991). In the Sacramento-San Joaquin Delta, winter chinook outmigrants generally occur from September through May as evidenced from trawling, seining, and State and Federal water project fish salvage data (CDFG 1993b).

Prior to construction of Shasta and Keswick Dams in 1945 and 1950, respectively, winter chinook were reported to spawn in the upper reaches of the Little Sacramento, McCloud, Pit and Fall rivers (Stone 1876, USFC 1900, Rutter 1904, Needham et al. 1941). Specific data relative to the historic run sizes of winter chinook prior to 1967 are sparse and anecdotal. The winter run probably numbered in the high tens of thousands and occasionally exceeded 100,000 (Yoshiyama et al. 1998).

Since the construction of Shasta and Keswick Dam, winter chinook spawning has primarily occurred between Red Bluff Diversion Dam and Keswick Dam. In some years, significant numbers of winter chinook may spawn below Red Bluff (RM 245), as far downstream as Woodson Bridge (RM 218). The population apparently thrived in the mainstem Sacramento River in the decades following the construction of Shasta and Keswick Dams; over 100,000 adults returned in 1969. However, by the early 1990s the population had declined to only a few hundred spawners.

Completion of the Red Bluff Diversion Dam in 1966 allowed estimates of all salmon runs to the upper Sacramento River based on fish counts at the fish ladders. Prior to 1986, the entire winter chinook population was monitored during the course of their spawning migration past RBDD. Beginning in 1986, the gates at RBDD have been raised for various time periods during their migration to enable freer passage to spawning grounds. Since 1990, the gates have been raised for up to 85% of the winter chinook migration period, such that about 15% of the run has been

Winter Chinook Escapement at RBDD




| Year | Adults | Age-3 RR |
|---|---|---|
| 1987 | 1,761 | |
| 1988 | 1,386 | |
| 1989 | 480 | |
| 1990 | 425 | 0.24 |
| 1991 | 134 | 0.10 |
| 1992 | 1,122 | 2.34 |
| 1993 | 267 | 0.63 |
| 1994 | 153 | 1.14 |
| 1995 | 1,296 | 1.16 |
| 1996 | 612 | 2.29 |
| 1997 | 480 | 3.14 |
| 1998 | 1,784 | 1.38 |
| 1999 | 885 | 1.45 |
| 2000 | 563 | 1.17 |

monitored rather than the entire run. The estimated number of winter chinook passing the dam from 1967 to 1969 averaged about 86,000. These annual fish counts document the dramatic

Figure 2. Estimate of total run at Red Bluff Diversion Dam. Estimates of adults component and age-3 replacement rates are shown in table.

decline of the winter chinook population (Figure 2). Since 1994, the population has shown signs of recovery. The age-3 replacement rate, an indicator of the cohort replacement rate, has been positive since 1994. On average, the population has increased annually by 56% over the past 7 year period. The total run has ranged between 1300 and 3200 fish during the past three years.

2. Coho Salmon

Coho salmon occur naturally in most major river basins around the North Pacific Ocean from central California to northern Japan (Laufle et al. 1986). After entering the ocean, immature coho salmon initially remain in near-shore waters close to the parent stream. Details regarding marine recoveries of CWT tagged coho are discussed by Weitkamp et al. (1995). In general, coho salmon remain closer to their river of origin than do chinook salmon, but coho may nevertheless travel several hundred miles (Hassler 1987). As a result, the ocean distributions of the three listed ESUs, while not identical, are substantially overlapping. During the 1980s and early 1990s, when coho were harvested in commercial and recreational fisheries, the majority of the coho caught off California originated from the Columbia River or from coastal Oregon streams. The prohibition of coho retention off California provides protection for the OC ESU as well as the SONCC and CCC ESUs. As with most species, coho are less abundant at the fringes of their range. Populations in California represent the southernmost extent of the species' North American range, which currently ends with the small populations found in Waddell and Scott creeks, just north of Monterey Bay.

Oregon Coastal Coho: Based on historic commercial landing statistics and estimated exploitation rates, coho salmon escapement to coastal Oregon rivers has been estimated at between 1 and 1.4 million fish in the early 1900s with harvest of nearly 400,000 fish (Mullen 1981; Lichatowich 1989). Recent spawning escapement from 1991-1993 has been estimated at an annual average of about 39,000 adults using stratified random sampling (Jacobs and Cooney 1991, 1992, 1993). This decline has been associated with a reduction in habitat capacity of nearly 50% (Lichatowich 1989). Current production potential for coho salmon in coastal Oregon rivers has been estimated at about 800,000 fish using stock-recruit models (Lichatowich 1989).

While the methods of estimating total escapement are not comparable between the historical and recent periods, these numbers suggest that current abundance of coho salmon on the Oregon coast may be less than 5% of that in the early part of this century. The Oregon Department of Fish and Wildlife (ODFW 1995) presented estimates of coho salmon abundance decline at several points of time from 1900 to the present. These data show a decline of about 75% from 1900 to the 1950s and further decline of about 90% since the 1950s.

Southern Oregon/Northern California Coastal Coho: The three major river systems supporting coho in the SONCC ESU are the Rogue, Klamath (including the Trinity), and Eel rivers.

Brown et al. (1994) reviewed the historic abundance, decline and present status of coho salmon in California. In estimating current abundance, the authors relied on a "20-fish rule:" if a stream with historic accounts of coho salmon lacked recent data, it was assumed to still support a run of 20 adults; if coho salmon were present in recent stream surveys, they used 20 adults or the most recent run estimate, whichever was larger. While the resulting estimates are rough approximations, they are generally comparable with other estimates (Bryant 1994; CDFG 1994; Maahs and Gilleard 1994).

Of the 396 streams within the range of the California portion of the SONCC ESU that were identified as once having coho salmon runs, recent survey information is available for 115 streams (29 percent). Of these 115 streams, 73 (64 percent) still support coho salmon runs while 42 (36 percent) have lost their coho salmon runs. The rivers and tributaries in the California portion of the SONCC ESU were estimated to have average recent run sizes of 7,080 natural spawners and 17,156 hatchery returns, with 4,480 identified as native fish occurring in tributaries having little history of supplementation with non-native fish (Brown et al. 1994).

Central California Coho: Estimated average coho salmon spawning escapement in the central California ESU for the period from the early 1980s through 1991 was 6,160 naturally spawning coho salmon and 332 hatchery spawned coho salmon (Brown et al. 1994). Of the naturally-spawning coho salmon, 3,880 were from the tributaries in which supplementation occurs (the Noyo River and coastal streams south of San Francisco). Only 160 fish in the range of this ESU (all in the Ten Mile River) were identified as "native" fish, lacking a history of supplementation with the non-native hatchery stocks. Based on redd counts, the estimated run of coho salmon in the Ten Mile River was 14 to 42 fish during the 1991-1992 spawning season (Maahs and Gilleard 1994).

Of 186 streams in the range of the central California ESU identified as having historic accounts of adult coho salmon, recent data exist for 133 (72 %). Of these 133 streams, 62 (47 %) have recent records of occurrence of adult coho salmon and 71 (53 %) no longer maintain coho salmon spawning runs (Brown et al. 1994).

## III. Environmental Baseline

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).

### A. Status of the Species and Critical Habitat within the Action Area

Chum, sockeye, and steelhead salmon are unlikely to be affected by the proposed research. However, some chinook and coho are likely to be caught on occasion as a result of the proposed studies. The discussion of the Environmental Baseline therefore focuses on the listed chinook and coho ESUs.

There are nine listed chinook ESUs (Puget Sound chinook, Snake River Fall chinook, Snake River Spring/Summer chinook, Lower Columbia River chinook, Upper Willamette River chinook, Upper Columbia River Spring chinook, Sacramento River Winter chinook, Coastal California chinook, and Central Valley Spring chinook) and three listed coho ESUs (Central California coho, Southern Oregon/Northern California Coasts coho, and Oregon Coast coho). More detailed discussions related to the Environmental Baseline for these ESUs can be found in recent biological opinions (Table 2), but the conclusions of these review are summarized below.

The assessments of the size, variability and stability of chinook and coho populations, described in the previous sections, are made in fresh water spawning and migratory environments and closely reflect the status of the species.

None of the inland critical habitat designated for the chinook and coho ESUs that are the focus of this opinion lies within the action area. Marine habitats (i.e., oceanic or nearshore areas seaward of the mouth of coastal rivers) are vital to the species, and ocean conditions are believed to have a major influence on chinook salmon survival (see review in Pearcy 1992). However, to date, there has been no apparent need for special management action to protect offshore areas and, as a result, they have not been included in designated critical habitat for any of the ESUs.

B. Factors Affecting the Species Environment within the Action Area

1. Washington, Oregon, California Coast Groundfish Fisheries

Salmon are taken incidentally in the groundfish fishery off Washington, Oregon, and California. NMFS has conducted section 7 consultations on the impacts of fishing conducted under the Pacific Coast Groundfish Fishery Management Plan (PCGFMP) on ESA listed species and concluded that impacts on species listed were low and not likely to jeopardize the listed species (NMFS 1996b, 1999a). NMFS has since reinitiated consultation on the PCGFMP. The reinitiation was precipitated because the bycatch of chinook in the whiting fishery exceeded the specified incidental take of chinook in 2000. (The incidental take statement anticipated an annual bycatch of 11,000 chinook per year; the bycatch of chinook in 2000 was 11,500.) The reinitiated consultation has not yet been completed, but will focus on additional management actions that can be taken in the fishery to keep bycatch within the specified limits.

Most salmon caught incidental to the whiting fishery are chinook. (The 1991-99 average annual catch of pink, coho, chum, sockeye, and steelhead in the whiting fishery are approximately 671, 272, 145, 16 and 0, respectively out of an annual catch of 210 metric tons of whiting). The incidental total catch of all chinook in the groundfish fisheries is generally low. The estimated catch of chinook in the whiting fishery for example has averaged 7,200 annually from 1991 to 2000. The incidental catch of chinook in other components of the groundfish fishery are comparable in magnitude to those in the whiting fishery (NMFS 1996). This compares to a catch of chinook in the ocean salmon fisheries off the Oregon and Washington coast that has averaged 156,000 annually during the same 1991 to 1999 time frame (PFMC 2000).

Because most of the whiting fishery occurs off the Oregon and Washington coast, the chinook ESUs that are most likely to be affected by the whiting fishery are those from the Columbia River Basin and Puget Sound. The most recent groundfish opinion (NMFS1999a) estimates the catch of Puget Sound, Lower Columbia River brights and Upper Willamette River chinook to be an occasional event in these fisheries based on an average of 3-5 CWTs recovered per year. The catch rates of Lower Columbia River spring and tule stocks are probably somewhat higher based on their higher incidence of catch in PFMC salmon fisheries. However, given the generally low total bycatch of chinook, the exploitation rate on these stocks was estimated to be <1% (NMFS 1999a). There have been no CWT recoveries of Upper Columbia River spring chinook in the groundfish fisheries suggesting that they are likely unaffected by the fishery.

2. Ocean Salmon Fisheries

Ocean salmon fisheries off California, Oregon, and Washington are managed to meet the increasingly complex combination of NMFS' requirements established through ESA section 7 consultation and management objectives established for key stocks under the PFMC Fishery Management Plan. Exploitation rates have declined substantially in recent years because of ESA and other conservation-related restrictions. The biological opinions referenced in Table 2 discuss the trends in harvest for each of the affected chinook and coho ESUs. Here we summarize that information by providing examples of harvest trends for selected ESUs representing north migrating chinook stocks (generally those from the Columbia Basin and Puget Sound), chinook

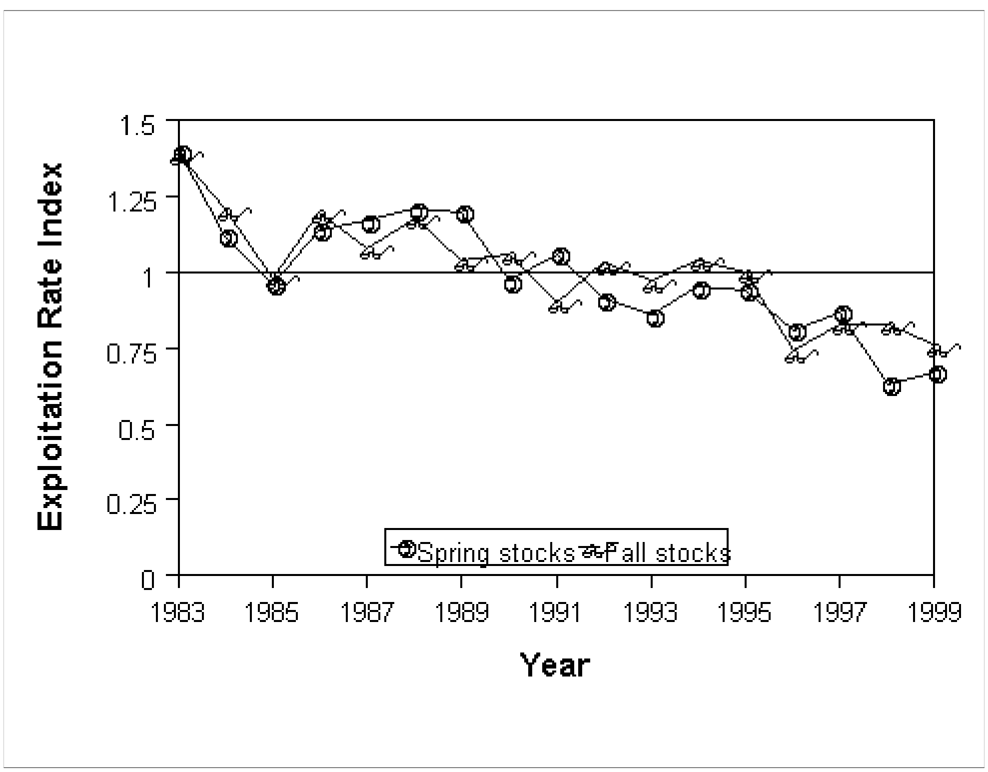
ESUs from California, and the listed coho ESUs that are affected primarily by fisheries off the Oregon and California coast.

The Puget Sound chinook ESU includes both spring and fall components. A time series of model estimates of total exploitation rates are available for the Puget Sound spring and fall chinook stocks. These are reported as an index relative to the 1989-93 average exploitation rate. Although the decline in exploitation rate is moderate relative to the 1989-93 base period, Figure 3 indicates that the exploitation rate has declined steadily, and more substantially since 1983.

The Lower Columbia River chinook ESU has three components including spring stocks, tule stocks, and far-north migrating bright stocks. These components have different distributions and are subject to different rates of harvest. Of these the tule component is affect most by the fisheries in the action area. The trend in exploitation rate from salmon fishing for tule stocks represents the general magnitude of proportional reductions for other chinook ESUs from the Columbia Basin.

The total brood year exploitation rates on tule stocks have averaged 0.68 through 1990 although there has been a pattern of decline over that time period (Table 6). Total exploitation rates for the 1991-1994 broods averaged 0.31 (Table 6). The distribution of the tule stocks is more southerly with the ocean harvest concentrated in Canadian and PFMC fisheries. Exploitation rates in the PFMC fishery averaged 0.23 through 1990 and 0.10 for the 1991-94 brood years. The long-term exploitation rate in the river fisheries averaged 0.11 (Table 6).

Figure 3. Total adult equivalent exploitation rate index for a composite of Puget Sound spring and fall chinook stocks relative to the 1989-93 average ER (NMFS 2000b).



The most recent 4 year average is 0.05. Tules are caught in the Strait of Juan de Fuca and San Juan sport fisheries at very low levels (D. Simmons, NMFS, pers. comm. to S. Bishop, NMFS). The average exploitation rate on Lower Columbia River tules in Puget Sound, Grays Harbor and Willapa Bay fisheries averaged 0.02 for the 1972-1990 brood years and 0.00 for the most recent brood years (1991-1994) (Table 6).

**Table 6. Summary of total adult equivalent exploitation rates for an aggregate of tule stocks from the Lower Columbia River chinook ESU (CTC unpublished).**

| | Tule (Oregon hatcheries, Cowlitz) | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Columbia R. | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | |
| 1975 | | | | | | |
| 1976 | 0.85 | 0.01 | 0.36 | 0.30 | 0.14 | 0.04 |
| 1977 | 0.77 | 0.03 | 0.29 | 0.35 | 0.09 | 0.01 |
| 1978 | 0.72 | 0.03 | 0.32 | 0.27 | 0.07 | 0.03 |
| 1979 | 0.78 | 0.03 | 0.29 | 0.34 | 0.09 | 0.03 |
| 1980 | 0.70 | 0.02 | 0.38 | 0.16 | 0.09 | 0.05 |
| 1981 | 0.67 | 0.03 | 0.43 | 0.08 | 0.10 | 0.03 |
| 1982 | 0.70 | 0.03 | 0.32 | 0.18 | 0.15 | 0.02 |
| 1983 | 0.75 | 0.02 | 0.24 | 0.23 | 0.23 | 0.03 |
| 1984 | 0.75 | 0.02 | 0.26 | 0.19 | 0.25 | 0.03 |
| 1985 | 0.74 | 0.02 | 0.27 | 0.28 | 0.15 | 0.02 |
| 1986 | 0.57 | 0.03 | 0.18 | 0.27 | 0.06 | 0.03 |
| 1987 | 0.51 | 0.06 | 0.19 | 0.21 | 0.05 | 0.00 |
| 1988 | 0.52 | 0.03 | 0.26 | 0.16 | 0.06 | 0.01 |
| 1989 | 0.67 | 0.03 | 0.20 | 0.37 | 0.06 | 0.01 |
| 1990 | 0.53 | 0.02 | 0.18 | 0.18 | 0.12 | 0.03 |
| 1991 | 0.30 | 0.03 | 0.25 | 0.01 | 0.01 | 0.00 |
| 1992 | 0.28 | 0.02 | 0.04 | 0.14 | 0.07 | 0.01 |
| 1993 | 0.26 | 0.06 | 0.10 | 0.03 | 0.07 | 0.00 |
| 1994 | 0.41 | 0.00 | 0.11 | 0.23 | 0.07 | 0.00 |
| 1976-1990 | 0.68 | 0.03 | 0.27 | 0.23 | 0.11 | 0.02 |
| 1991-1994 | 0.31 | 0.03 | 0.12 | 0.10 | 0.05 | 0.00 |

The chinook salmon fisheries off California, which target Sacramento River fall run chinook, have in recent years been constrained to meet FMP objectives for Klamath River fall chinook, NMFS' ESA consultation standard for listed Sacramento River winter chinook and three listed ESUs of coho.

In 1993, the Department of the Interior quantified the federally reserved fishing rights of the Yurok and Hoopa Valley Indian tribes of the Klamath Basin. Application of Tribal fishing rights has required significant reductions in the ocean harvest rate on Klamath River fall chinook (Figure 4), and will permanently constrain California and Oregon commercial troll seasons relative to pre-1993 seasons. In 1996 and 1997, NMFS issued biological opinions requiring reductions in fishing effort off California in order to protect Sacramento River winter chinook. The 1997 opinion required that the PFMC reduce ocean harvest sufficiently to increase the adult spawning escapement by 31% relative to a base period (1989-1993). The restrictions necessary to meet this requirement have been applied to both the California recreational and commercial salmon fisheries. Figure 5 shows annual California troll and recreational effort since 1978 (PFMC 2000). Recreational effort averaged 188 thousand angler trips from 1996 to 1998, compared to an average of 227 during the prior 10 year period. Nominal commercial effort has declined substantially over the past 20 years. It is likely, however, that the effective effort has not declined as sharply, since those participants that remain in the fishery are the usually the more proficient.

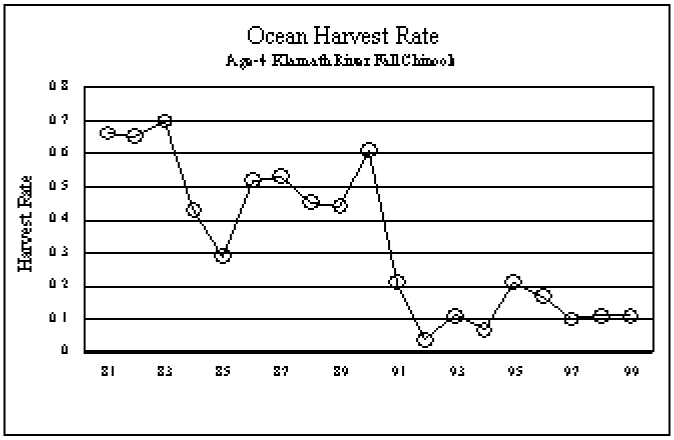



Figure 4 Annual age-4 ocean harvest rates for Klamath River fall chinook salmon. From PFMC 2000. The annual ocean harvest rate is the fraction of age-4 fish available at the beginning of the fishing season that are caught by ocean fisheries.

The annual abundance of Central Valley chinook salmon is estimated by the Central Valley Index (CVI), which is the sum of the ocean chinook harvest south of Point Arena and the Central Valley adult chinook spawning escapement of the same year. The harvest of Central Valley chinook is evaluated by the Central Valley Ocean Harvest Index, which is calculated as the total catch of chinook south of Point Arena divided by the CVI. The Ocean Harvest Index is an indicator of the annual harvest rate (catch/(catch+escapement)) of Central Valley chinook. In the past four years there has been a substantial reduction in the Central Valley Ocean Harvest Index (Figure 6). Commercial harvest rates, as indicated by the commercial component of the Ocean Harvest Index have been declining since the late 1980s. From 1986 to 1993 the commercial harvest averaged 56% of the CVI abundance index, compared to an average of 44% from 1994 to 1999. Recreational harvests averaged 17% of the CVI between 1986 and 1992 and 20% of the CVI between 1993 and 1999.

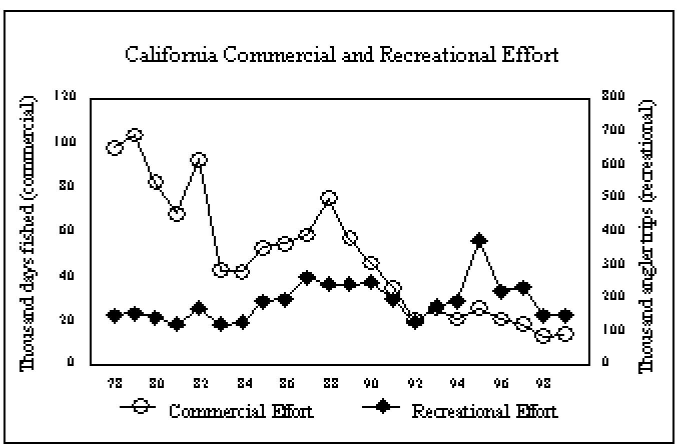



Figure 5 Commercial and recreational salmon fishing effort off California. Note that effort in the two sectors are measured differently and are not comparable. From PFMC 2000.

Several factors bias the Central Valley Ocean Harvest Index as an indicator of harvest rate of Central Valley fall run chinook. The catch of chinook salmon south of Point Arena (including stocks originating from outside the Central Valley) may not equal the total ocean catch of Central Valley chinook. Estimates of the magnitude of the recreational catch in the Central Valley have not consistently been available and are not included in the estimate of chinook escapement to the Central Valley. It is not clear how these factors bias the Index with respect to actual harvest rates of Central Valley chinook.

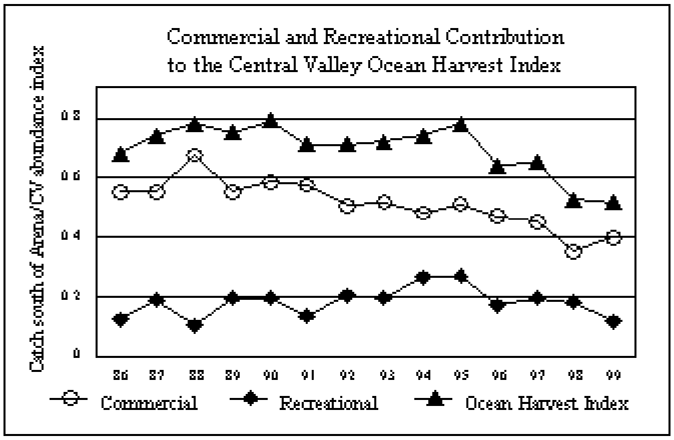



Figure 6. Central Valley Ocean Harvest Index and relative contributions of the recreational and commercial sectors to the Index. From PFMC 2000a.

Since 1994, the retention of coho has been prohibited in PFMC fisheries south of Cape Falcon, Oregon. Coho are still impacted, however, as a result of hook-and-release mortality in chinook-directed fisheries. Figure 7 shows the reduction in the ocean exploitation rate index on Oregon Production Index (OPI) coho stocks (which includes the three listed ESUs) that has occurred as a result of implementing non-retention fisheries off Oregon and California. Harvest impacts on coho stocks can be assessed through the use of models based on recoveries of CWTs from ocean fisheries and hatchery returns. The Fishery Regulation Assessment Model (FRAM) estimates stock specific exploitation rates and is used by the PFMC's Salmon Technical Team (STT) to evaluate proposed fishing plans relative to the PFMC's management objectives. The FRAM uses the magnitude of the chinook catch during the recent years of nonretention to provide an estimate of the exploitation rate on coho resulting from hooking mortality. The FRAM currently includes stocks that represent Oregon Coastal and Southern Oregon/Northern California coho but not Central California coho. Impacts to Central California coho must therefore be assessed more qualitatively. Nonetheless it is apparent that exploitation rates on listed coho ESUs have been reduced substantially in recent years. Exploitation rates during the decade of the 70's often exceeded 80%. In recent years exploitation rates have generally been less than 10%.

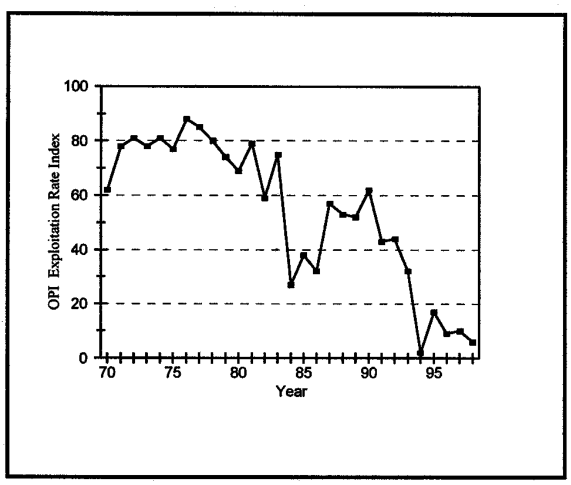



Figure 7. OPI exploitation rate index (From Table 1-11 PFMC 1999).

### 3. Natural Factors Causing Variability in Population Abundance

Changes in the abundance of chinook populations are a result of variations in freshwater and marine environments. For example, large scale changes in climatic regimes, such as El Niño, likely affect changes in ocean productivity; much of the Pacific coast was subject to a series of very dry years during the first part of the decade which adversely affected some the stocks. In more recent years, severe flooding has adversely affected some stocks. For example, the anticipated low return of Lewis River bright fall chinook in 1999 and 2000 is attributed, at least in part, to flood events during both 1995 and 1996.

Chinook salmon are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation likely also contributes to significant natural mortality, although the levels of predation are largely unknown. In general, chinook are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebounding of seal and sea lion populations, following their protection under the Marine Mammal Protection Act of 1972, has resulted in substantial mortality for salmonids. In recent years, for example, sea lions have learned to target UWR spring chinook at Willamette Falls and have gone so far as to climb into the fish ladder where they can easily pick-off migrating spring chinook.

A key factor that has substantially affected many west coast salmon stocks has been the general pattern of long-term decline in ocean productivity. The mechanism whereby stocks are affected is not well understood. The pattern of response to these changing ocean conditions has differed between stocks, presumably due to differences in their timing and distribution. It is presumed that ocean survival is driven largely by events between ocean entry and recruitment to a sub-adult life stage. One indicator of early ocean survival can be computed as an index of CWT recoveries at age 2 relative to the number of CWTs released from that brood year. Indices are available for Upper Willamette River spring chinook, Lewis River fall chinook, and Nooksack Spring chinook and Samish Fall chinook, which are indicators of spring and fall-type stocks from Puget Sound. The patterns differ between stocks, but each shows a highly variable or declining trend in early ocean survival with very low survivals in recent years (Figures 8-11).

**Figure 8. Early ocean survival rate index for Lewis River wild chinook (LCR ESU).**

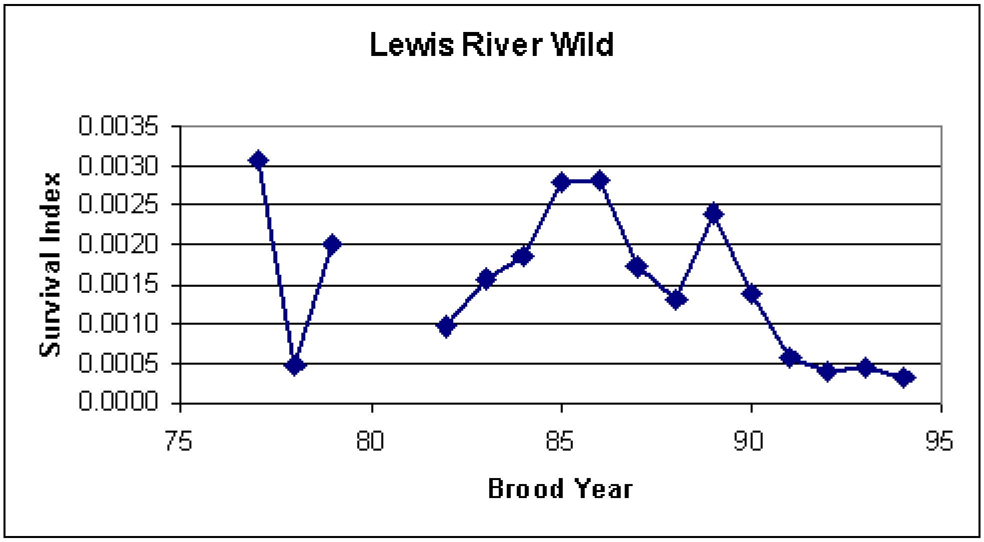



**Figure 9. Early ocean survival rate index for Willamette River spring chinook (UWR ESU).**

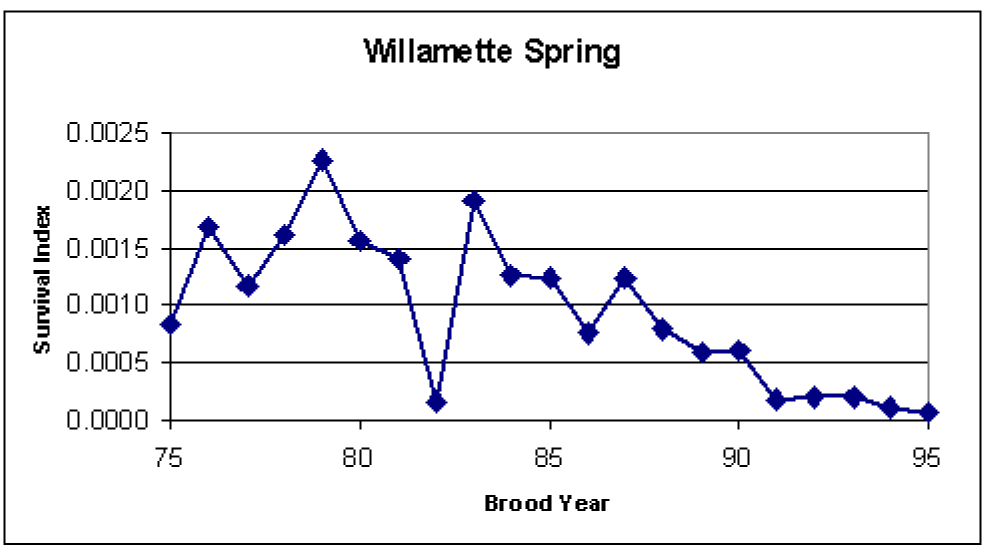


**Figure 10. Early ocean survival rate index for Nooksack early chinook (PS ESU).**

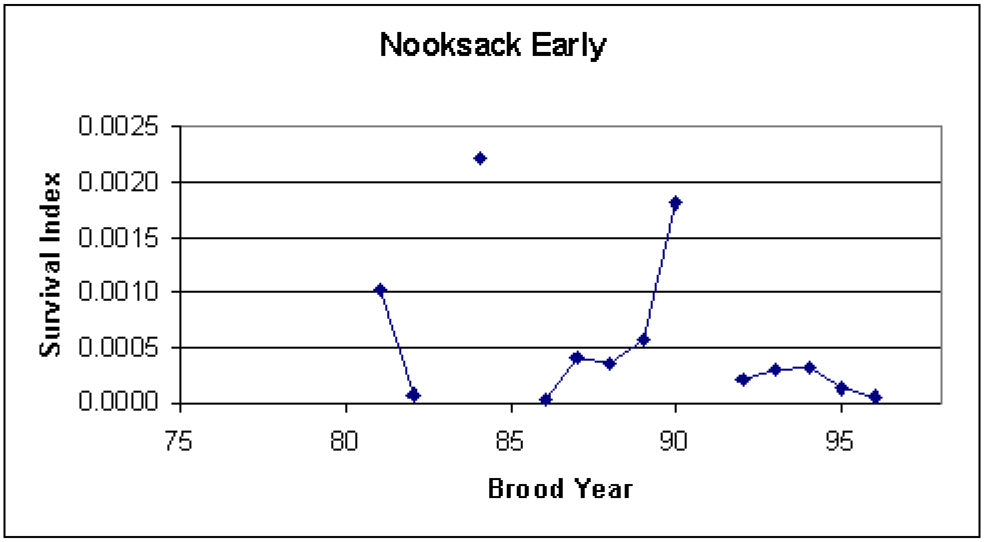
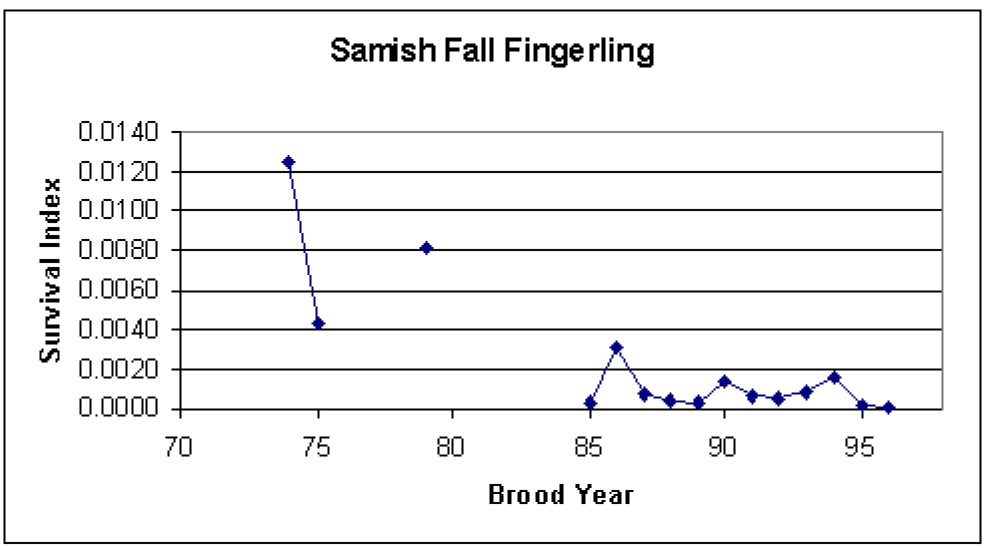



**Figure 11. Early ocean survival rate index for Samish fall chinook (PS ESU).**



Recent evidence suggests that marine survival of salmon species fluctuates in response to 20-30 year long periods of either above or below average survival that is driven by long-term cycles of climatic conditions and ocean productivity (Cramer et al. 1999). This has been referred to as the Pacific Decadal Oscillation (DO). It is apparent that ocean conditions and resulting productivity affecting many of northwest salmon populations have been in a low phase of the cycle for some time. Smolt-to-adult return rates provide another measure of survival and the effect of ocean conditions on salmon stocks. The smolt-to-adult survival rates for Puget Sound chinook stocks, for example, dropped sharply beginning with the 1979 broods to less than half of what they were during the 1974-1977 brood years (Cramer et al. 1999). The variation in ocean conditions has been an important contributor to the decline of many stocks. However, the survival and recovery of these species depends on the ability of these species to persist through periods of low ocean survival when stocks may depend on better quality freshwater habitat and lower relative harvest rates.

## IV. Effects of the Action

The standards for determining jeopardy are set forth in section 7(a)(2) of the ESA as defined at 50 CFR §402.02. This section of the biological opinion applies those standards in determining whether the proposed research studies are likely to jeopardize the continued existence of one or more of the listed ESUs that may be adversely affected by the studies. This analysis considers the direct, indirect, interrelated, and interdependent effects of the proposed research and compares them against the environmental baseline to determine if the proposed research will appreciably reduce the likelihood of survival and recovery of these listed salmon in the wild. The jeopardy determinations are also based on a consideration of the magnitude of salmon catch and bycatch by species, the geographic distribution of the catch and bycatch, and the available information indicating the relative magnitude of impacts to each ESU. Consideration is also given to the proposed actions taken to reduce the catch of listed fish, and the long-term benefits associated with need for such research. The jeopardy determinations were analyzed using quantitative estimates of incidental take from previous years' research where available, but other determinations are largely qualitative at this time. NMFS must rely on the best available information in making its judgement about the risk of the proposed action to the newly listed ESUs.

Critical habitat has now been designated for all of the affected ESUs. Offshore marine areas that are not included as part of the designated critical habitat. However, marine and freshwater areas in the Columbia River and Puget Sound are included. Most of the research activities will occur offshore, and are outside the range of the designated habitat. Gear that is used during these research studies do not substantively affect the habitat.

The potential adverse impacts of the proposed activities is the anticipated catch of listed salmonids. Two letters from the NWFSC provided the needed analysis of listed stocks for each NMFS research projects (Schiewe 2000a, Schiewe 2000b). These impacts were estimated using various sources including where practicable previous research, relative run size, estimated distribution patterns, and migrational timing relative sampling. It is anticipated that chinook and coho salmon ESUs are most likely to be impacted by these studies. The total annual bycatch of other listed species (chum, sockeye, and steelhead) are summarized and reviewed briefly in

Schiewe (2000a) and Schiewe (2000b), but are not analyzed in detail in this biological opinion because of the consistently low level of estimated catch.

**Salmonid Predation Study**

The maximum estimated number of chum caught in the salmonid predation study is two fish per year; the maximum estimated number of sockeye and steelhead is one fish each per year (Schiewe 2000a). Given this low level of catch, and relative abundance of listed and unlisted fish in the area, it is unlikely that any listed chum, sockeye, and steelhead will be taken in the proposed study.

Results from sampling in prior years suggests that there may be some incidental catch of chinook and coho. Fish from the following listed chinook salmon ESUs may be captured incidentally during the study: Snake River Fall, Snake River Spring/Summer, Puget Sound, Lower Columbia River, Upper Willamette River, and Upper Columbia River Spring. However, given the relatively large production of hatchery fish and non-listed stocks adjacent to the study area (e.g., Columbia River, and Oregon and Washington coastal stocks), and the low numbers of incidentally captured chinook salmon, the impacts to listed fish will generally be quite low. (See following discussion for more detail)

Although the large mesh size in the mouth and body of the net allows small juvenile salmonids (i.e., yearling and subyearling fishes) to pass, smaller meshes in the cod-end will retain small salmonids. The smaller meshes are needed to collect northern anchovy, Pacific sardine, Pacific herring, and other "alternative" prey that will potentially influence juvenile salmonid predation rates.

The largest number of salmonids captured in a single month during prior years was in July during the 1999 sampling season, when 307 <1 age chinook salmon were captured. The length of these chinook salmon (most <130 mm FL), the large number of adipose clips (31), and obvious fin wear, indicated that most, if not all, of these fish were probably recently released fall chinook hatchery fish. In 2000, and future years, the study should capture far fewer fall chinook salmon because there will be no sampling in late July, when the migrational period for fall chinook begins.

The juvenile chinook salmon captured from April to June 1999 were mostly yearling fish (88), but to be conservative, the maximum catch of juvenile chinook was assumed to be 500 fish. The associated estimate of listed juvenile chinook is seven fish, which may come from anyone of several ESUs (Schiewe 2000a). Schiewe (2000a) also conservatively estimated that as many as 20 adult chinook may be taken, although only seven were observed in the 1999 sampling.

The projected maximum catch of 40 adult chinook and 150 adult coho, which was used to assess the impacts to listed salmon in the 1997 informal biological opinion (Stelle, Jr. 1997), turned out to be relatively accurate for coho, with only 37 fish caught in 1999, the first full year of sampling; of these 36 were juveniles. However, the projected catch of chinook was underestimated, with 520 fish caught in the 1999 sampling season, including 395 juveniles, 25 sub-adults, and 7 adult chinook. The majority of the chinook juveniles encountered in 1999 occurred during July at the end of the year's sampling schedule, a majority of these were caught in one sampling tow. With the sampling in July eliminated from the now proposed study design for the ongoing research, the catch of juvenile chinook is expected to be greatly reduced.

Fish from ESA listed coho salmon ESUs that could be incidentally caught during the research sampling includes: Central California, Southern Oregon/Northern California Coasts, and Oregon Coast.

Only 36 juvenile coho salmon were captured in 1999. Most of these fish (29) were caught in June. It is thought that all of these were probably non-listed fish because 21 of the 29 had clipped adipose fins (hatchery origin) and the relatively abundant Washington coastal coho stocks are not an ESA listed stock. The estimated maximum yearly catch of coho salmon includes 55 fish, five adults and 50 juveniles, approximately four of which may be from listed ESUs (Schiewe 2000a). Juvenile coho caught incidentally in the Columbia River mouth are most likely to come from the Oregon coastal ESU. Any adult coho salmon that may be encountered will be released, whereas juveniles will be retained (they do not survive capture) and saved for analysis by an ongoing NMFS study of salmonid survival in the Columbia River plume.

Overall, NMFS anticipates that no more than 7 juvenile and 1 adult chinook salmon, and no more than 4 coho salmon (juveniles and adults combined), will be taken by activities associated with the salmon predation study on an annual basis. While adults will be released, all of the juveniles are expected to be mortalities. Over the four year life of the permit, the proposed studies may incidentally take up to 28 juveniles and 4 adult chinook salmon, and 16 juveniles or adult coho salmon.

The current status of the species and environmental baseline point to the very depressed status of some of the listed ESU's affected by the research activities. Since these fish may originate from one of several chinook and coho ESU's, NMFS cannot accurately estimate the short- or long-term effects on individual ESU's. However, it is highly unlikely that the incidental take associated with the research would be concentrated on a single ESU. Even if all of the take did occur on a single ESU, the low numbers of fish anticipated to be taken would not result in an appreciable reduction in the numbers, distribution, or reproductive success of listed chinook or coho salmon. Incidental take of chum, sockeye, and steelhead is not anticipated due to the low numbers of listed fish expected to be present in the action area.

**Juvenile Salmon Distribution Study**

The maximum estimated number of chum caught in the juvenile salmon distribution study is two fish per year; the maximum estimated number of sockeye, steelhead, and cutthroat is one fish each per year (Schiewe 2000b). Given this low level of catch, it is unlikely that any listed chum, sockeye, and steelhead will be taken in the proposed study.

The offshore surveys proposed could intercept juvenile chinook salmon from a number of ESUs (Schiewe 2000b). Based on coded-wire-tag recoveries from adults, juveniles from the Sacramento Winter-Run, Central Valley Spring-Run, Central Valley Fall- and Late-Fall Run, California Coastal, Upper Klamath and Trinity River, Southern Oregon and Northern California, Oregon Coast, and Snake River Fall-Run ESUs may be in the geographic area of the surveys. Of these ESUs: the Sacramento River Winter-Run ESU is listed as Endangered under the ESA, and the Snake River Fall-Run, Coastal California, and Central Valley Spring-Run ESUs are listed as Threatened. However, given the relatively large production of hatchery fish and non-listed stocks adjacent to the study area (e.g., Oregon and Washington coastal stocks), and low percentage of ESA listed chinook salmon in the study area, overall catch estimates are conservatively high, and will actually capture few listed chinook salmon.

The estimated maximum yearly catch of chinook salmon in the juvenile distribution study is 600, all of which would be juveniles (Schiewe 2000b). Of these the estimated take of listed juvenile chinook is 54 (20 in June and 34 in September). These are most likely to be from the California Coastal ESU, although other ESUs may be affected as well. The overall effect of the research on the species' survival and recovery is reduced further because the marine survival of juvenile chinook is relatively low. Schiewe (2000b) reported that marine survival of juveniles is < 50% survival, but the actual smolt to adult survival for chinook is typically in the range of 1 to 4% (PSC 1999).

The possible ESA listed coho salmon stocks that could be incidentally caught during the research sampling includes: Central California, Southern Oregon/Northern California Coasts, and Oregon Coast. Coded wire tag recoveries suggest that some non-listed Columbia River coho could be captured off of the Oregon and California coast. Additionally, there are hatchery programs that produce non-listed fish. For the proposed surveys the study allocated the incidental take of listed coho salmon based on the relative adult returns to each ESU.

All adult coho salmon will be released, whereas juveniles will be retained (they do not survive capture) and will be saved for laboratory analysis. The estimated maximum yearly catch of coho salmon is approximately 350, of which approximately 168 would be from listed ESUs (Schiewe 2000b), including Central California coho, Southern Oregon/Northern California Coasts coho, and Oregon Coast coho. However, the overall effect of the research on the ESUs is quite low. The incidental catch estimates are estimated high to be conservative. In addition, the marine survival of juveniles is generally low. Schiewe (2000b) again reported that marine survival was < 50%, but the actual smolt to adult survival for Oregon coastal coho is typically 1 to 2% (Solazzi 2000; pers. comm., R.G. Kope, NMFS July, 10, 2000; pers. comm., M.F. Solazzi, ODFW, July, 11, 2000), and in some years in certain drainages may be as high as 10% (pers. comm., M.F. Solazzi, ODFW, July, 11, 2000).

Overall of the listed and non-listed salmonids anticipated to be taken during the juvenile salmon distribution study, NMFS anticipates that no more than 54 juvenile and 0 adult listed chinook salmon, and no more than 168 juvenile and 0 adult listed coho salmon, will be taken by activities associated with this study on an annual basis. Similar to the salmonid predation study, all of the juveniles taken are expected to be mortalities. Over the four year life of the permit, the proposed study may incidentally take up to 216 juvenile chinook and 672 coho salmon.

The current status of the species and environmental baseline point to the very depressed status of some of the listed ESU's affected by the research activities. Since these fish may originate from one of several chinook and coho ESU's, NMFS cannot accurately estimate the short- or long-term effects on individual ESU's. However, it is highly unlikely that the incidental take associated with the research would be concentrated on a single ESU. Even if all of the take did occur on a single ESU, the low numbers of fish anticipated to be taken would not result in an appreciable reduction in the numbers, distribution, or reproductive success of listed chinook or coho salmon. Incidental take of chum, sockeye, and steelhead is not anticipated due to the low numbers of listed fish expected to be present in the action area.

## V. Cumulative Effects

Cumulative effects are defined as the "effects of future state or private activities, not involving federal activities, which are reasonably certain to occur within the action area of the federal action subject to consultation" (50 CFR 402.02). For the purposes of this analysis, the action area includes areas off the coast of Washington, Oregon, and California that are involved with the two research studies. The production of chinook and coho salmon, and steelhead by state hatchery programs will likely continue and has the potential to add cumulative impacts to listed populations in the ocean, through competition and predation. Hatchery salmon production also provides targeted harvest opportunity in the ocean through increasing chinook and coho salmon abundance above that which would occur naturally, although harvest mortality associated with fisheries is specifically considered in harvest opinions. At this time, the extent of cumulative impacts from hatchery salmon production is not known. Further evaluation is warranted but this can best be done as part of an overall assessment of species specific hatchery programs. Because the action area is limited to the study areas, no additional cumulative effects to the listed species are anticipated.

## VI. Integration and Synthesis of Effects

The NWFSC proposes to conduct two research projects which may incidentally capture listed salmonids. The salmonid predation study is likely to capture Lower Columbia River chinook, Upper Willamette River chinook, Upper Columbia River Spring chinook. Chinook salmon stocks from the listed California ESUs (i.e. Sacramento River Winter chinook, Coastal California chinook, and Central Valley Spring chinook) and possibly Snake River Fall chinook are most likely to be taken in the juvenile distribution study. Both studies may adversely affect any of the three listed coho ESUs (i.e. Central California coho, Southern Oregon/Northern California Coasts coho, and Oregon Coast coho).

Overall the combined annual anticipated catch of listed and non-listed fish for these two studies is 1,120 chinook and 405 coho, virtually all of which will be juveniles (i.e. 20 adult chinook and five adult coho). All of the juveniles captured are expected to be mortalities, adults will be released. Of these 61 chinook and 172 coho are anticipated to be from one of several listed ESUs. NMFS has assumed the effects of these research activities to be minimal because 1) the estimated number of listed fish taken is very low, 2) the impact estimates themselves are conservatively high and therefore likely overestimate the actual impact, and 3) there will be little effect on returning adults because of low natural marine survival rates of juvenile chinook (1-4%) and coastal coho (1-2%). For perspective, the 1999 catch in the ocean salmon fisheries off the west coast harvested 478,200 adult chinook and 91,800 adult coho salmon (PFMC 2000).

Overall, NMFS concludes that the annual levels of incidental take of listed chinook and coho salmon anticipated during the conduct of these studies is not likely to appreciably reduce the numbers, distribution, or reproductive success of these species in a way that reduces their ability to survive and recover in the wild. Incidental take of other listed species, including chum, sockeye, and steelhead is not anticipated due to the low numbers of these species which may be present in the action area.

Although there is some limited expected take associated with the research projects, the projects are designed to benefit listed species in general by contributing to a better understanding of predation mortality and the links between ocean conditions and salmon survival in the marine environment that are critically important to the survival and recovery of listed salmon. The two proposed studies considered in this opinion are part of a coordinated research plan for estuarine and ocean research on Pacific salmon (Brodeur et al. 2000). The research objectives are described in more detail in section I.A. The information gained through this coordinated research will contribute greatly to our understanding the relationship between ocean conditions and survival of salmonids during this critical stage of their lives. NMFS concludes that the benefits of the projects outweigh the limited effect of the expected take.

For the currently listed salmonid species, critical habitat does not include marine areas affected by the proposed study. The proposed actions are therefore not likely to destroy or adversely modify designated critical habitat for any of the listed salmonid ESUs.

## VII. Conclusion

After reviewing the current status of each of the listed salmonid species (Table 1), the environmental baseline for the action area, the effects of the proposed individual actions, and the cumulative effects, it is NMFS' biological opinion that conduct of the proposed salmonid predation and juvenile distribution studies, as proposed, are not likely to jeopardize the continued existence of Sacramento River winter, Snake River fall, Snake River spring/summer, Central Valley spring, California Coastal, Puget Sound, Lower Columbia River, Upper Willamette River, or Upper Columbia River spring chinook salmon ESU's; Hood Canal summer-run, or Columbia River chum salmon ESU's; Central California Coastal, Southern Oregon/Northern California Coastal, or Oregon Coastal coho salmon ESU's; Snake River or Ozette Lake sockeye salmon ESU's; or Southern California, South-Central California, Central California Coast, Upper Columbia River, Snake River Basin, Lower Columbia River, California Cental Valley, Upper Willamette River, Middle Columbia River, or Northern California steelhead ESU's, and is not likely to destroy or adversely modify designated critical habitat.

## INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by NMFS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limit to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by the agencies so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The agencies have a continuing duty to regulate the activity covered by this incidental take statement. If the agencies (1) fail to assume and implement the terms and conditions or (2) fail to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the agencies or applicant must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement. [50 CFR §402.14(i)(3)]

### I. Amount or Extent of Incidental Take

The **annual** expected take of the proposed activities for the salmonid predation study through the year 2004 will not exceed the specified number of listed fish by species. These takes may come from any combination of the specific species of listed ESUs shown in Table 1.

Chinook salmon: no more than 7 juveniles and 1 adult.
Coho salmon: no more than 4 fish, adults and juvenile combined.
Chum salmon: no anticipated take.
Sockeye Salmon: no anticipated take.
Steelhead: no anticipated take.

The **annual** expected take of the proposed activities for the juvenile salmon distribution study through the year 2004 will not exceed the specified number of listed fish by species. These takes may come from any combination of the specific species of listed ESUs shown in Table 1.

Chinook salmon: no more than 54 juveniles, and no adults.
Coho salmon: no more than 168 juveniles, and no adults.
Chum salmon: no anticipated take.

Sockeye Salmon: no anticipated take.
Steelhead: no anticipated take.

## II. Effect of the Take

In the accompanying biological opinion, NMFS determined that the level of anticipated take in the proposed research is not likely to jeopardize the continued existence of any of the listed or proposed to be listed salmonid ESUs (Table 1), or result in the destruction or adverse modification of their critical habitat.

## III. Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize the take of listed fish and will apply to all activities described in this opinion.

1. Detailed information shall be recorded on the catch and observed impacts on salmonids.
2. The sampling activities shall be conducted in such a manner as to minimize adverse impacts to listed species.

## IV. Terms and Conditions

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. In order to be exempt from the prohibitions of sections 9 and 4(d) of the ESA, NMFS must continue to comply with all of the terms and conditions listed in terms and conditions to implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. Periodic reports with updates to impact tables shall be completed at the end of each years sampling season and submitted to NMFS, Northwest Region (Christopher Wright, F/NWR2, is the contact).
2. If impacts increase from those specified above, then NMFS, Northwest Region will consult with project biologists and evaluate the situation, and where necessary recommend changes to reduce impacts.
3. Juvenile salmon captured for the predation study in the surface trawl do not survive collection, and will be saved for stomach analysis, and coded-wire tag (CWT) information and other data and provided to an ongoing NWFSC/Estuarine and Ocean Ecology Program study of juvenile salmonid growth in relation to the Columbia River plume dynamics.
4. Juvenile salmon taken in the juvenile salmon distribution study will be transported back to the Hatfield Marine Science Center laboratory in Newport, OR, or the Northwest Fisheries Science Center, Seattle, WA, for detailed dissection and analysis.
5. Adult salmon will be identified and measured and gently released back into the ocean unless they have a CWT. Adult salmonids with CWT will be sacrificed so place of origin can be determined.

NMFS believes that no more than 61 juvenile and 4 adult chinook salmon, and no more than 172 juvenile (of which 4 could be adult) coho salmon will be incidentally taken as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. NMFS, Northwest Fisheries Science Center must immediately provide an explanation of the causes of the taking and review with NMFS, Office of Protected Resources, the need for possible modification of the reasonable and prudent measures.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS has not currently identified conservation recommendations for the proposed activities.

## REINITIATION OF CONSULTATION

This concludes formal consultation on the Pacific Coast Groundfish FMP as amended by Amendment 11. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take specified in the Incidental Take Statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, NMFS' NWFSC must immediately request reinitiation of formal consultation.

## REFERENCES

Allen, R.L., and T.K. Meekin. 1973. An evaluation of the Priest Rapids chinook salmon spawning channel, 1963-1971. Wash. dept. Fisheries, Technical Report 11:1-52 p.

Banks, M.A., V.K. Rashbrook,, M.J. Calavetta, C.A. Dean, and D. Hedgecock. 2000. Analysis of microsatellite DNA resolves genetic structure and diversity of chinook salmon (*Oncorhynchus tshawytscha*) in California's Central Valley. Can. J. Fish. Aquat. Sci. 57: 915-927.

Becker, D.C. 1970. Temperature, timing, and seaward migration of juvenile chinook salmon from the central Columbia River. AEC Research and Development Report, Battelle Northwest Laboratories. Richland, WA. 21 p.

Bevan, D., J. Harville, P. Bergman, T. Bjornn, J. Crutchfield, P. Klingeman, J. Litchfield. 1994. Snake River Salmon Recovery Team: Final recommendations to National Marine Fisheries Service. May 1994.

Biological Requirements Work Group (BRWG). 1994. Analytical methods for determining requirements of listed Snake River salmon relative to survival and recovery. Progress Report, October 13, 1994. 129 p w/ Appendices.

Briggs, J.C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. Calif. Dep. Fish Game, Fish Bull. 94:1-62.

Brodeur, R.D., G.W. Boehlert, E. Casillas, M.B. Eldridge, J.H. Helle, W.T. Peterson, W.R. Heard, S.T. Lindley, and M.H. Schiewe. 2000. A Coordinated Research Plan for Estuarine and Ocean Research on Pacific Salmon. Fisheries, 25(6): 7-16.

Brown, L.R., P.B. Moyle, and R.M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. N. Am. J. Fish. Manage. 14:237-261.

Bryant, G.J. 1994. Status review of coho salmon in Scott Creek and Waddell Creek, Santa Cruz County, California. NMFS, SW Region, Protected Species Management Division, 102 p.

Bugert, R., P. LaRiviere, D. Marbach, S. Martin, L. Ross, and D. Geist. 1990. Lower Snake River Compensation Plan salmon hatchery evaluation program 1989 annual report. Report to the U.S. Fish and Wildlife Service, Cooperative Agreement 14-16-0001-89525, 145 p.

Burgner, R.L. 1991. The life history of sockeye salmon (*Oncorhynchus nerka*). *In* C. Groot and L. Margolis (eds.), Life history of Pacific salmon. Univ. British Columbia Press; Vancouver, B.C.

California Department of Fish and Game (CDFG). 1965. California fish and wildlife plan. Three volumes. Sacramento, CA. (Available from California Department of Fish and Game,Inland Fisheries Division, 1416 Ninth St., Sacramento, CA 95814.)

California Department of Fish and Game (CDFG). 1993a. Restoring Central Valley streams: A plan for action. Inland Fisheries Division.

California Department of Fish and Game (CDFG). 1993b. Memorandum (2/3/93) from Frank Fisher, CDFG Red Bluff, to Deborah McKee, CDFG Inland Fisheries Division. 2 p. + appendices.

California Department of Fish and Game (CDFG). 1994. Petition to the California Board of Forestry to list coho salmon (*Oncorhynchus kisutch*) as a sensitive species. CDFG Rep., 35p.

California Department of Fish and Game (CDFG). 1998. Report to the Fish and Game Commission: A status review of the spring-run chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River drainage.

Calkins, R.D., W.F. Durand, and W.H. Rich. 1940. Report of the board of consultants on the fish problem of the upper Sacramento River. Stanford Univ., 34 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Campbell, E.A. and P.B. Moyle. 1990. Historical and recent population sizes of spring-run chinook salmon in California. In: Proceedings, 1990 Northwest Pacific chinook and coho salmon workshop, pp. 155-216. American Fisheries Society, Humboldt State University, Arcata, California.

Cannamela, D.A. 1992. Potential impacts of releases of hatchery steelhead trout "smolts" on wild and natural juvenile chinook and sockeye salmon. A white paper. Idaho Department of Fish and Game, Boise, ID.

Clark, G.H. 1929. Sacramento-San Joaquin salmon, Oncorhynchus tshawytscha, fishery of California. California Department of Fish and Game Bulletin 17, 73 p.

Cramer, S.P., J. Norris, P. Mundy, G. Grette, K. O'Neal, J. Hogle, C. Steward, and P. Bahls. 1999. Status of chinook salmon and their habitat in Puget Sound. Volume 2, Final Report. June 1999.

CTC. 1999. Unpublished analysis of CWT recoveries through 1998, from Dell Simmons, NMFS.

Foerster, R.E. 1955. The Pacific salmon (Genus Oncorhynchus) of the Canadian Pacific coast, with particular reference to their occurrence in or near freshwater. Int. N. Pac. Fish. Comm. Bull. 1, 56 p.

Flint, T. and G. Zillges. 1980. Little Bear Creek coho salmon stream life study. Wash. Dep. Fish. Prog. Rep. 124, 40 p.

Fraser, F.., E.A. Perry, and D.T. Lightly. 1983. Big Qualicum River salmon development project, Volume I: A biological assessment, 1959-1972. Can. Tech. Rep. Fish. Aquat. Sci. 1189, 198 p.

Fry, D.H., Jr. 1961. King salmon spawning stocks of the California Cental Valley, 1940-1959. California Fish and Game 47: 55-71.

Fulton, L.A. 1968. Spawning areas and abundance of chinook salmon, *Oncorhynchus tshawytscha*, in the Columbia River Basin past and present. U.S. Fish. Wildl. Serv. Spec. Sci. Rep. Fish. 571:26

Gilbert, C.H. 1912. Age at maturity of Pacific coast salmon of the genus *Oncorhynchus*. Bull. U.S. Fish Comm. 32:57-70.

Hassler, T.J. 1987. Species Profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) - coho salmon. U.S. Fish and Wildlife Service Biological Report 82 (11.70). U.S. Army Corps of Engineers, TR EL-82-4. 19 pp.

Healey, M.C. 1983 Coastwide distribution and ocean migration patterns of stream- and ocean-type chinook salmon, *Oncorhynchus tshawytscha*. Can. Feild-Nat. 97:427-433.

Healey, M.C. 1986. Optimum size and age at maturity in Pacific salmon and effects of size-selective fisheries. Can. Spec. Publ. Fish. Aquat. Sci. 89:39-52.

Healey, M.C. 1991. The life history of chinook salmon (*Oncorhynchus tshawytscha*). In C. Groot and L. Margolis (eds.), Life history of Pacific Salmon. Univ. of British Columbia Press. Vancouver, B.C.

Jacobs, S.E. and C.X. Cooney. 1991. Improvement of methods used to estimate the spawning escapement of Oregon coastal natural coho salmon. Oreg. Dep. Fish Wildl., Fish Div. Prog. Rep. 1991. 24 p.

Jacobs, S.E. and C.X. Cooney. 1992. Improvement of methods used to estimate the spawning escapement of Oregon coastal natural coho salmon. Oreg. Dep. Fish Wildl., Fish Div. Prog. Rep. 1992. 23 p.

Jacobs, S.E. and C.X. Cooney. 1993. Improvement of methods used to estimate the spawning escapement of Oregon coastal natural coho salmon. Oreg. Dep. Fish Wildl., Fish Div. Prog. Rep. 1993. 28 p.

Laufle, J.C., G.B. Pauley, and M.F. Shepard. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest): coho salmon. U.S. Fish and Wildlife Service. Biol. Rep. 82(11.48), 18 p.

Leidy, R. A. and G.R. Leidy. 1984. Life stage periodicities of anadromous salmonids in the Klamath River Basin, northwestern California. U.S. Fish and Wildlife Service, Sacramento, California, 38 p.

Lichatowich, J.A. 1989. Habitat alteration and changes in abundance of coho *(Oncorhynchus kisutch*) and chinook *(O. tshawytscha*) salmon in Oregon's coastal streams. In C.D. Levings, L.B. Holtby, and M.A. Henderson (editors), Proceedings of the National Workshop on Effects of Habitat Alteration on Salmonid Stocks, May 6-8, 1987, Nanaimo, B.C., p. 92-99. Can. Spec. Publ. Fish. Aquat. Sci. 105.

Lichatowich, J.A., L.G. Gilbertson and L.E. Mobrand. 1993. A concise summary of Snake River chinook production. Prepared for the Snake River Salmon Recovery Team, by Mobrand Biometrics, Inc. Vashon Island, WA.

Loeffel, R.E. and H.O. Wendler. 1968. Review of the Pacific coast chinook and coho salmon resources with special emphasis on the troll fishery. Prepared by the U.S. working group of the Informal Committee on Chinook and Coho, 107 p.

Maahs, M. and J. Gilleard. 1994. Anadromous salmonid resources of Mendocino coastal and inland rivers 1990-91 through 1991-92: An evaluation of rehabilitation efforts based on carcass recovery and spawning activity. Report to CDFG, Fish. Div., Fish. Restor. Prog., Contract F-9364, 66 p.

Marr, J.C. 1943. Age, length, and weight studies of three species of Columbia River salmon (*Oncorhynchus keta*, O. gorbuscha, and O. kisutch). Stanford Ichthyol. Bull. 2(6):157-197.

Matthews, G.M. and R.S. Waples. 1991. Status review for Snake River spring and summer chinook salmon. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-200. 75p.

McElhany, P., M. Ruckelsoaus, M.J. Ford, T. Wainwright, and E. Bjorkstedt. Draft - Viable salmonid populations and the recovery of evolutionarily significant units. NMFS. December 13, 1999. 161 p.

McPhail, J.D., and C.C. Lindsey. 1970. Freshwater fishes of Northwestern Canada and Alaska. Bull. Fish. Res. Board Canada 173: 381.

Miller, R.J., and E.L. Brannon. 1982. The origin and development of life-history patterns in Pacific salmon. *In* E.L. Brannon and E.O. Salo (eds.), Proceedings of the Salmon and Trout Migratory Behavior Symposium. Univ. Washington Press; Seattle, Washington.

Milne, D.J. 1957. Recent British Columbia spring and coho salmon tagging experiments, and a comparison with those conducted from 1925 to 1930. Can. Fish. Res. Board Bull. 113:1-56.

Mullen, R.E. 1981. Estimates of the historical abundance of coho salmon Oncorhynchus kisutch (Walbaum) in Oregon Coastal Streams and in the Oregon Production Index Area. Oregon Department of Fish and Wildlife Population Dynamics and Statistical Services Section, Corvallis, OR. 9 p.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1999. Status review update for deferred ESUs of west coast chinook salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35.

National Marine Fisheries Service (NMFS). 1991a. Factors for decline. A supplement to the notice of determination for Snake River spring/summer chinook salmon under the Endangered Species Act. 72p. (Available from: NMFS, Protected Resources Division, 525 N.E. Oregon St., Suite 500, Portland OR 97232.)

National Marine Fisheries Service (NMFS). 1991b. Factors for decline. A supplement to the notice of determination for Snake River fall chinook salmon under the Endangered Species Act. June 1991. 55 p.

National Marine Fisheries Service (NMFS). 1995. Proposed recovery plan for Snake River salmon. March 1995.

National Marine Fisheries Service (NMFS). 1996. Reinitiated of Section 7 Consultation - Biological Opinion: Fishing conducted under the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Northwest Region, Seattle, WA, 1996. 9pp.

National Marine Fisheries Service (NMFS). 1997. Memorandum from G. Matlock to P. Montanio. Re: Reinitiation of section 7 consultation on the fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California as it affects the Sacramento River winter chinook salmon. February 18, 1997. 3 p. (with Attachment).

National Marine Fisheries Service (NMFS). 1999a. Reinitiated of Section 7 Consultation - Biological Opinion: Fishing conducted under the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Northwest Region, Seattle, WA, 1996. 9pp.

National Marine Fisheries Service (NMFS). 1999b. Endangered Species Act - Section 7 Consultation. Supplemental Biological Opinion and Incidental Take Statement on the Pacific Coast Salmon Plan and Amendment 13 to the Plan. April 28, 1999. 39 pp. (with appendices).

National Marine Fisheries Service (NMFS). 2000a. Endangered Species Act - Reinitiated Section 7 Consultation - Effects of Pacific Coast Ocean and Puget Sound Salmon Fisheries During the 2000-2001 Annual Regulatory Cycle. NMFS, Protected Resources Division. April 28, 2000. 96 p.

National Marine Fisheries Service (NMFS). 2000b. Biological opinion. 2000 Treaty Indian and

Non-Indian fall season fisheries in the Columbia Basin. July 31, 2000. 74 p.

National Marine Fisheries Service (NMFS). 2000c. Biological opinion. Impacts of treaty Indian and non-Indian year 2000 winter, spring, and summer season fisheries in the Columbia River basin, on salmon and steelhead listed under the Endangered Species Act. February 29, 2000. 79 p.

National Marine Fisheries Service (NMFS). 2000d. Endangered Species Act - Reinitiated Section 7 Consultation - Effects of the Pacific Coast Salmon Plan on California Central Valley Spring-Run Chinook and California Coastal Chinook Salmon. NMFS, Protected Resources Division. April 28, 2000. 31 p.

Needham, P.R. , O.R. Smith, and H.A. Hanson. 1941 Salmon salvage problems in relation to Shasta Dam, California, and notes on the biology of Sacramento River salmon. Transactions of the American Fisheries Society 70:55-69.

Nicholas, J. 1995. Status of Willamette spring-run chinook salmon relative to Federal Endangered Species Act. Report to the National Marine Fisheries Service. Oregon Department of Fish and Wildlife. 44 p.

Olsen, E., P. Pierce, M. McLean, and K. Hatch. 1992. Stock summary reports for Columbia River anadromous salmonids Volume 1: Oregon. U.S. Dep. Energy, Bonneville Power Administration. Project No. 88-108.

Oregon Department of Fish and Wildlife (ODFW). 1995. Oregon coho salmon biological status assessment and staff conclusion for listing under the Oregon Endangered Species Act. (Commission decision draft). Oreg. Dep. Fish Wildl., Portland, February 22, 1996, 59 p.

Oregon Department of Fish and Wildlife (ODFW). 1997. Backgrounder - Willamette spring chinook. February 21, 1997. 6 p.

Oregon Department of Fish and Wildlife (ODFW). 1998a. Spring chinook chapters - Willamette basin fish management plan. Oregon Department of Fish and Wildlife. March 1998. 39 p.

Oregon Department of Fish and Wildlife (ODFW). 1998b. Briefing paper - Lower Columbia River chinook ESU. October 13, 1998. 7 p.

Pearcy, W.G., 1992. Ocean ecology of North Pacific salmonids. Univ. Washington Press, Seattle, 179 p.

Perry, C.A. and T.C. Bjornn. 1991. Examination of the extent and factors affecting downstream emigration of chinook salmon fry from spawning grounds in the upper Salmon River. Unpublished report, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow.

PFMC. 1999. Review of 1998 Ocean Salmon Fisheries. February 1999.

PFMC. 2000. Review of 1999 Ocean Salmon Fisheries. February 2000. Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 224, Portland, Oregon 97201.

Pritchard, A.L. 1940. Studies on the age of the coho salmon (*Oncorhynchus kisutch*) and the spring salmon (*Oncorhynchus tshawytscha*) in British Columbia. Trans. R. Soc. Can., Serv. 3, 34(V):99-120.

PSC. 1999. Pacific Salmon Commission Joint Chinook Technical Committee Report - 1995 and 1996 Annual Report. Report TCCHINOOK(99)-2, March 19, 1999.

Ricker, W.E. 1972. Hereditary and environmental factors affecting certain salmonid populations. *In* R.C. Simon and P.A. Larkin (eds.), The stock concept in Pacific salmon. MacMillan Lectures in Fisheries. Univ. British Columbia; Vancouver, B.C.

Rutter, C. 1904. Natural history of the quinnat salmon. U.S. Fish Commission Bulletin 22:66-141.

Salo, E. and W.H. Bayliff. 1958. Artificial and natural production of silver salmon, Oncorhynchus kisutch, at Minter Creek, Washington. Wash. Dep. Fish. Res. Bull. 4, 76 p.

Sandercock, F.K. 1991 Life history of coho salmon (*Oncorhynchus kisutch*). In C. Groot and L. Margolis (editors), Pacific salmon life histories, p. 396-445. Univ. British Columbia Press, Vancouver.

Schiewe, M.H. 2000a. Request to Reinitiate ESA Informal Consultation Regarding a Study Sampling Salmonid Predators Off the Mouth of the Columbia River. NMFS, Northwest Fisheries Science Center, Fish Ecology Division, Memorandum, February 22, 2000. 17 p.

Schiewe, M.H. 2000b. Request for Section 7 ESA Informal Consultation Regarding a GLOBEC Study Sampling Distribution of Juvenile Salmon and Associated Biota Off Oregon and Northern California. NMFS, Northwest Fisheries Science Center, Fish Ecology Division, Memorandum, February 23, 2000. 27 p.

Shapovalov, L. And A.C. Taft. 1954. The life histories of the steelhead rainbow trout (Salmo gairdneri gairdneri) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Calif. Dep. Fish Game, Fish Bull. 98, 375 p.

Solazzi, M.F., S.L. Johnson, B. Miller, and T. Dalton. 2000. Salmonid Life-Cycle Monitoring Project, 1998 and 1999 - Oregon Plan for Salmon and Watersheds: Monitoring Report No. OPSW-ODFW-2000-2, March 2, 2000. 31 p.

Speaks, S. 1999. Letter to W. Stelle Jr., NMFS re Consultation concerning impacts of proposed 2000 Treaty Indian fisheries (January 1 - July 31) in the Columbia River Basin on salmon species listed under the ESA. December 21, 1999. 3 p. w/ Attached Biological Assessment.

Stelle, Jr., W. 1997. ESA Informal Consultation Regarding a Proposed Juvenile Salmonid - Marine Fish Predation Study. NMFS, Northwest Region, Memorandum, June 11, 1997. 3p.

Stelle, Jr., W. 2000. Endangered Species Act - Section 7 Consultation on a Study Sampling Salmonid Predators Off the Mouth of the Columbia River and a GLOBEC Study Sampling Distribution of Juvenile Salmon and Associated Biota Off Oregon and Northern California. NMFS, Northwest Region, Memorandum, April 24, 2000. 4 p.

Stone, L. 1876. Report of operations in California in 1873. U.S. Commission of Fish and Fisheries, Report of the Commissioner for 1873-4 and 1874-5, appendix B, part 22:377-429, Washington, D.C.

Taylor, E.B. 1991. A review of local adaptation in Salmonidae, with particular reference to Pacific and Atlantic salmon. Aquaculture 98:185-207.

USFC (U.S. Commission for Fish and Fisheries). 1900. Report of the Commissioner for the year ending June 30, 1899:XCVI-C, Washington , D.C.

Vogel, D.A. and K.R. Marine. 1991. Guide to upper Sacramento chinook salmon life history. Report to U.S. Bureau of Reclamation, Central Valley Project. CH2M Hill, Inc., Redding, California. 55 pp.

Waples, R.S., R.P Jones, Jr., B.R. Beckman, and G.A. Swan. 1991. Status Review for Snake River fall chinook salmon. NOAA Technical Memorandum. NMFS F/NWC-201. June 1991. 73 p.

Washington Department of Fisheries (WDF), Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildl., Olympia, 212p. + 5 regional volumes.

Wright, S.G. 1970. Size, age, and maturity of coho salmon in Washington's ocean troll fishery. Wash. Dep. Fish., Fish Res. Papers 3(2):63-71.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-24.

Yoshiyama, R.M., F.W. Fisher, and P.B. Moyle. 1998. Historical abundance and decline of chinook salmon in the Central Valley region of California. N. Am. J. Fish. Manag. 18:487-521.